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*As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.*


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# *EDITORIAL COMMENT*

## New Readers

### *The Purpose of this Issue*

IT is no new departure for *The Wireless World* to have what is described as a New Readers' Number. We have done so for several years past and the object has always been to provide an opportunity for making *The Wireless World* more widely known, especially amongst those who are growing up to take an interest in wireless, either as a prospective occupation or as a hobby.

No attempt is made to plan this issue with extra pages or in fact to do anything which might be regarded as a bait to attract readers to this issue in particular; but the object is to include in it articles designed to stimulate interest and to bring up to date the knowledge of those who may have neglected wireless during the summer months. At the same time, the issue is kept as nearly as possible representative of the general run of issues such as may be expected in the future.

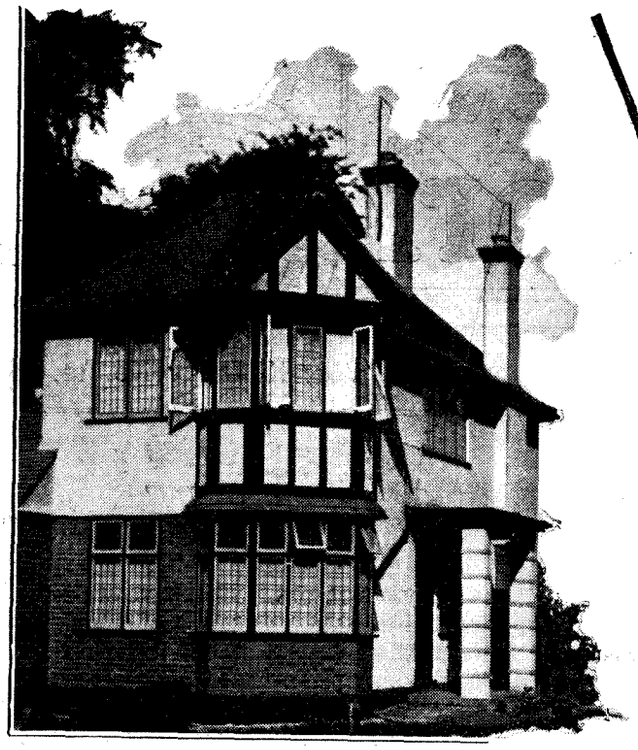
### *Status of Readers*

To be a regular reader of *The Wireless World* has come to be regarded in wireless circles, including the professional sphere, almost in the nature of a qualification in itself. The paper has always aimed at catering for those who are seriously interested in wireless, either professionally or as a hobby. We do not expect to number amongst our readers those whose interest is merely superficial. We have never attempted, even in the early days when broadcasting was—so to speak—"a nine days' wonder," to mislead the reader with untenable claims for circuits and designs for receivers which we have put out. Nor have we supported sensational claims of inventors or manufacturers unless those claims could be substantiated after scientific investigation. It is this policy which has built up for *The Wireless World* its high reputation in wireless circles and has carried the reader with it to the point which justifies the suggestion made above that to be a regular reader is in the nature of a qualification in itself.

### *Policy Maintained*

It will continue to be our aim to devote much of our space to education, paying particular attention to providing news of every technical development as it takes place, and whenever the opportunity arises giving constructional designs which will interpret in a practical form new ideas as they develop. Theoretical articles of a general instructional character will continue to form an important section of the paper and special attention will be devoted to those subjects which require to be reviewed from time to time, in order to facilitate the understanding of practical developments occurring periodically.

The success which, we believe, has in the past attended the efforts of the editorial staff to meet the needs of readers, has been very largely the outcome of the interest which readers themselves have taken in the paper and its activities. It is only by keeping in constant touch with readers and receiving their individual letters that the editorial staff is able to maintain close contact, and we hope that readers will continue, as in the past, to write to us unhesitatingly in regard to their interests and problems; not forgetting to give us the benefit of suggestions whenever the opportunity occurs.



# What To Do This

## A DOMESTIC INSTALLATION—NOT JUST A SET

WHILE the Editor is at the front door welcoming new readers to *The Wireless World*, I beg to offer a sub-welcome to this corner of it. For the benefit of the uninitiated I would explain that the purpose of cathode rays in general is to make plain to the eye the workings of radio which would otherwise be obscure. My object, therefore, is mainly to assist readers in understanding the more advanced articles elsewhere in this paper. If the authors had to digress every time to explain the terms they used they would take a very long time to get anywhere. So, on the whole, things are explained here that elsewhere must for the sake of brevity be taken for granted. I admit there are a few exceptions, due to the enthusiasm of the moment. Incidentally, I am always glad for readers to tell me of any subjects which they have particular difficulty in understanding.

After that personal apology, we proceed.

### Plenty To Do

Winter, with its vista of long evenings, lies ahead. Now that radio seems to have become a matter for vast mechanised factories, what does the poor amateur do? The answer, with American terseness, is "*Plenty*!"

In the old and almost exclusively amateur days, radio used to be an affair of many bits and pieces strung together with wires. That wasn't commercial. The factories set to work and turned out sets all tidied up into neat boxes, until nowadays people cannot imagine anything else. They get quite puzzled over such a thing as a "playing desk," as a gramophone pick-up and motor unit is generally known. "Is it a gramophone or not?" If you say it is, they wonder why they can't get a tune out of it; and if you say it isn't they ask what it *is*. And a visitor was astounded when he came into my house and found that my receiver had no built-in loud speaker.

This present state of affairs has a lot in its favour, of course, but in my opinion it has gone too far. Compare the telephone, which is a thoroughly standardised and commercialised product if anything is. The Post Office does not attempt to make everybody take it in the form of a neat, self-contained instrument. You can have the bell fixed just where it is most convenient, even if it means running many yards of wire around the house; and you are not obliged to put up with the lightning arresters where they are visible all the time. Nor are you compelled to go to one particular room in the house when you are rung up; you can carry the 'phone about with you and plug it in. Or, better still, have several instruments scattered around in the most useful places.

I don't know how other people feel about it, but, personally, I have a strongly rooted objection to getting out of bed and padding down into a chilly room to answer or to make a call; and that is putting it mildly if the reason for being in bed is a heavy cold. So an extra 'phone at the bedside is a boon hardly to be estimated in terms of the comparatively small extra cost.

**Mealtime music: the dining room is one of the first places to be considered when the question of installing extension speakers comes up.**

This is not meant to be a free advertisement for the G.P.O.; it is merely to emphasise that the same arguments apply, even more strongly, to radio installations. Note, *installations* rather than *sets*. But in most of the homes I ever see, anybody who has the bad luck to be laid up for a while is deprived of broadcasting just when he could do with it most.

Suggestion No. 1, then, for a Winter, 1938-9 Great Modernisation Programme, is to see that provision is made for extension loud speakers. Years ago, when moving-coil speakers had to be provided with field magnetising current, there was a reasonable excuse for failing to do so. Now that efficient permanent-magnet loud speakers are available at less than the cost of the older energised models, that excuse disappears.

Even in the room where the receiver is located, the loud speaker is preferably separate. The point is that if the set is near enough for reaching the controls from the easy chair (as, of course, it should be) it is much too near for the best listening. One of the best places is a far corner of the room. The usual position in commercial consoles and radio-gramophones, namely, a few inches from the carpet, is all wrong. Such remnants of high notes as manage to proceed from these instruments are muffled among upholstery and feet. Unlike low notes, they are greatly weakened unless they can travel more or less straight to the ear. Hence my face brightened when I saw loud-speaker firms bringing out models to suspend from the

# Winter

By "CATHODE RAY"

*Courtesy Regentone Products*
**Real luxury : remote control of volume, "on-off" or even of station selection add to the attractions of an extension speaker.**

picture-rail in the corner of the room. An excellent position; not in the way, speaking straight to the ear, and unlikely to have objects planked in front of it.

There are various things that can be done to improve loud speakers. Information on heart-shaped baffles, acoustic labyrinths, and other improvements that lend themselves to home construction, have recently appeared in *The Wireless World*.

Now is the time to overhaul the aerial-earth system.

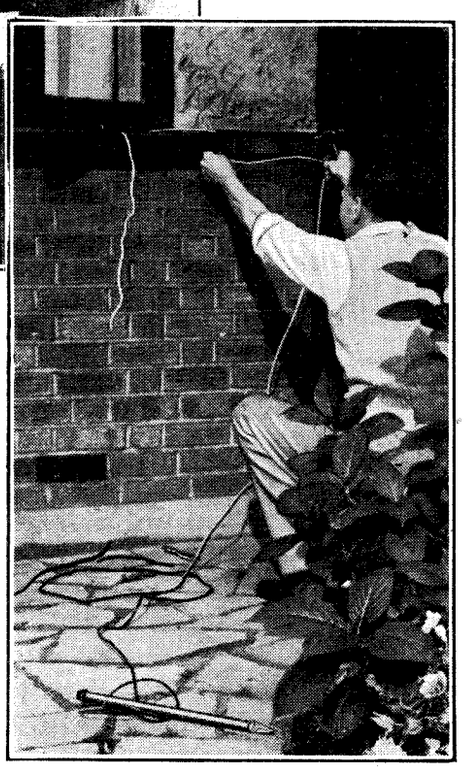
Extension loud speakers immediately reveal the need for remote control. Volume can easily be controlled at the speaker itself. Simple schemes for switching the receiver on and off can be contrived, or bought at moderate cost. More comprehensive control, including tuning and, perhaps, other things, is generally fairly expensive and involves the design of the receiver itself.

Passing on quickly, for it is impossible to give details of how to carry out all these suggestions, there is another department outside the receiver itself which, nevertheless is one of the most important as regards results—the aerial. After many years during which the aerial has been shamefully neglected (if you have any doubt about this, keep your eyes outside the window during your train journey up to Town) it is once more receiving attention, and a number of special types are sold, particularly for improving the proportion of programme to locally generated interference. Even if you do not feel inclined to go so far as an entirely new aerial, can you say that your present one is as neat and efficient as it might be? Could it be made more secure against winter gales? Or prevented from flapping about and perhaps touching walls or trees? Or the average height be raised? If so, it would be as well to do something about it before outdoors seems a less inviting place for wireless work. And remember that "aerial" is meant to include "earth" as well.

## Interference Suppressors

The aerial is not the only point where interference suppression can be effective. Fitting suppressors in the mains connection, or to guilty appliances in the house, may help in giving a noiseless background for reception.

Then I mentioned gramophone playing desks. Sometimes deplorably crude outfits can be seen for playing records. Following the same home-comfort policy as before, the proper thing is a neat unit to have



*Courtesy Belling and Lee*
**A modern aerial, if necessary of the anti-interference type, improves signal/noise ratio and appearance.**

by the chair, comprising motor turntable, pick-up, volume control, preferably tone controls too, and an earthed screened lead to the pick-up terminals on the receiver, to exclude hum.

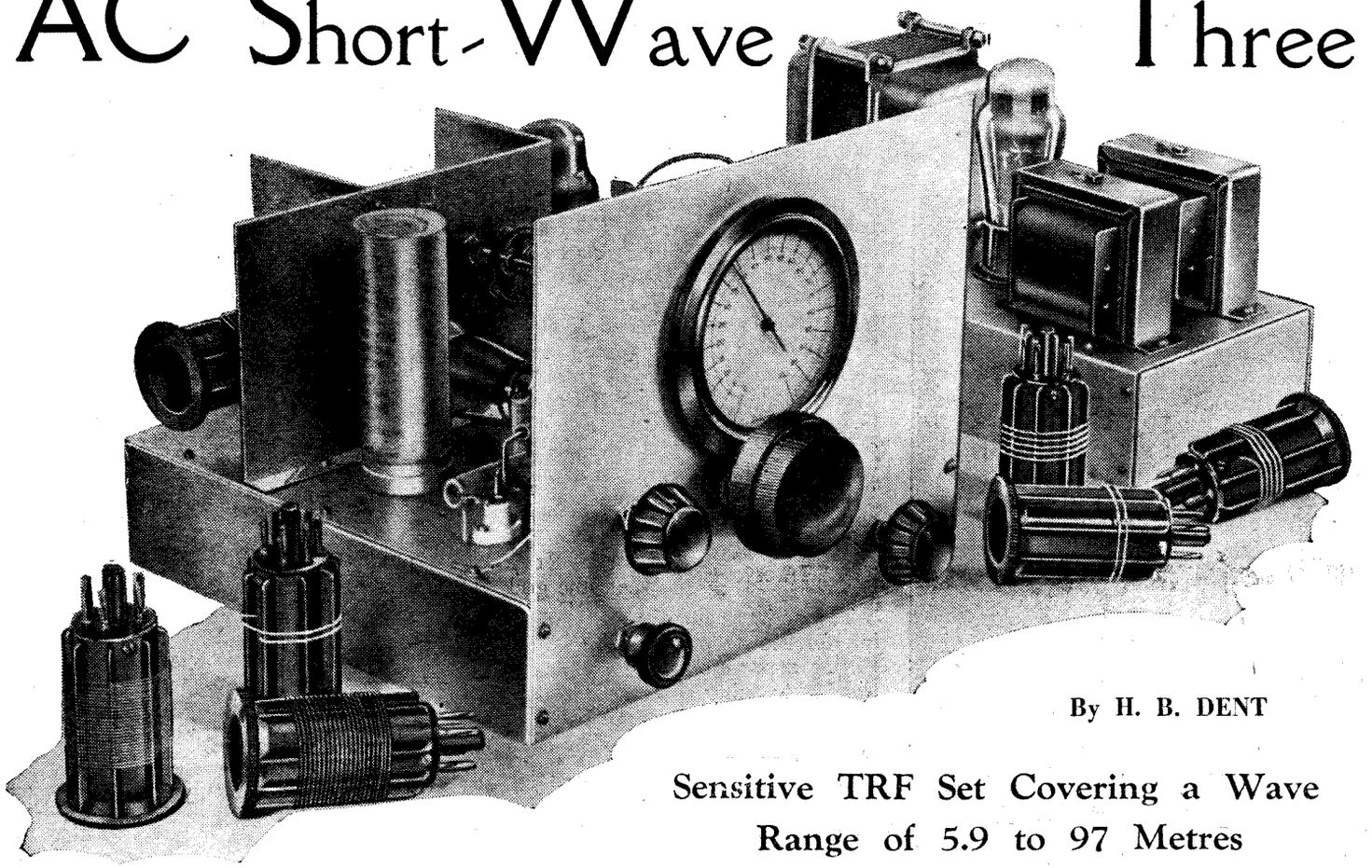
If you are a quality enthusiast and have finished a really good amplifier for reproducing records and broadcasting on ordinary wavelengths, how about making up an ultra-short wave receiver for the high-quality transmissions that are now sometimes put out when the sound transmitter is not being used for television? I have said nothing about television itself, for television fans are quite busy enough without any suggestions from me.

It is obviously impossible to include constructional details of any of the things mentioned. They are given fairly frequently in *The Wireless World*. My object just now has been to give some idea of how many things can be done towards improving one's apparatus and extending its usefulness, and to stimulate the putting in hand of programmes of modernisation and reconstruction. There are innumerable other things to do; and I haven't even dared to tackle the receiver itself. And as there is always a certain amount of "service" work to be done, a beginning can be made on simple apparatus for this purpose, leading up perhaps to a proper "lab."

In fact, enthusiasm for the winter programme has reached such a pitch that I can no longer refrain from poetry:

**"The world is so full of a number of things**
**That I'm sure we should all be as happy as kings."** **(R. L. S.)**

# AC Short-Wave Three



By H. B. DENT

## Sensitive TRF Set Covering a Wave Range of 5.9 to 97 Metres

THE design of this short-wave receiver follows very closely the lines of the three-valve battery set which was described in *The Wireless World* of May 12th last. It may, in fact, be regarded as an AC version of that set, for plug-in coils of a similar kind are employed and the same detector and reaction scheme is adopted.

The opportunity has been taken to simplify the coil winding and the grid tappings on both aerial and RF coils are omitted. Simplification is not the only reason for this change, as it was felt that being a mains set a loud speaker would be the best form of reproducer to employ, and consequently greater amplification has had to be obtained from both the RF and detector stages. Actually the selectivity has not suffered by these changes, and it is as good as can be hoped for in a set having two tuned circuits.

Reaction, of course, helps immensely in this respect, and as any TRF short-wave set relies very largely on reaction for both sensitivity and selectivity, particular attention has been given to the method of

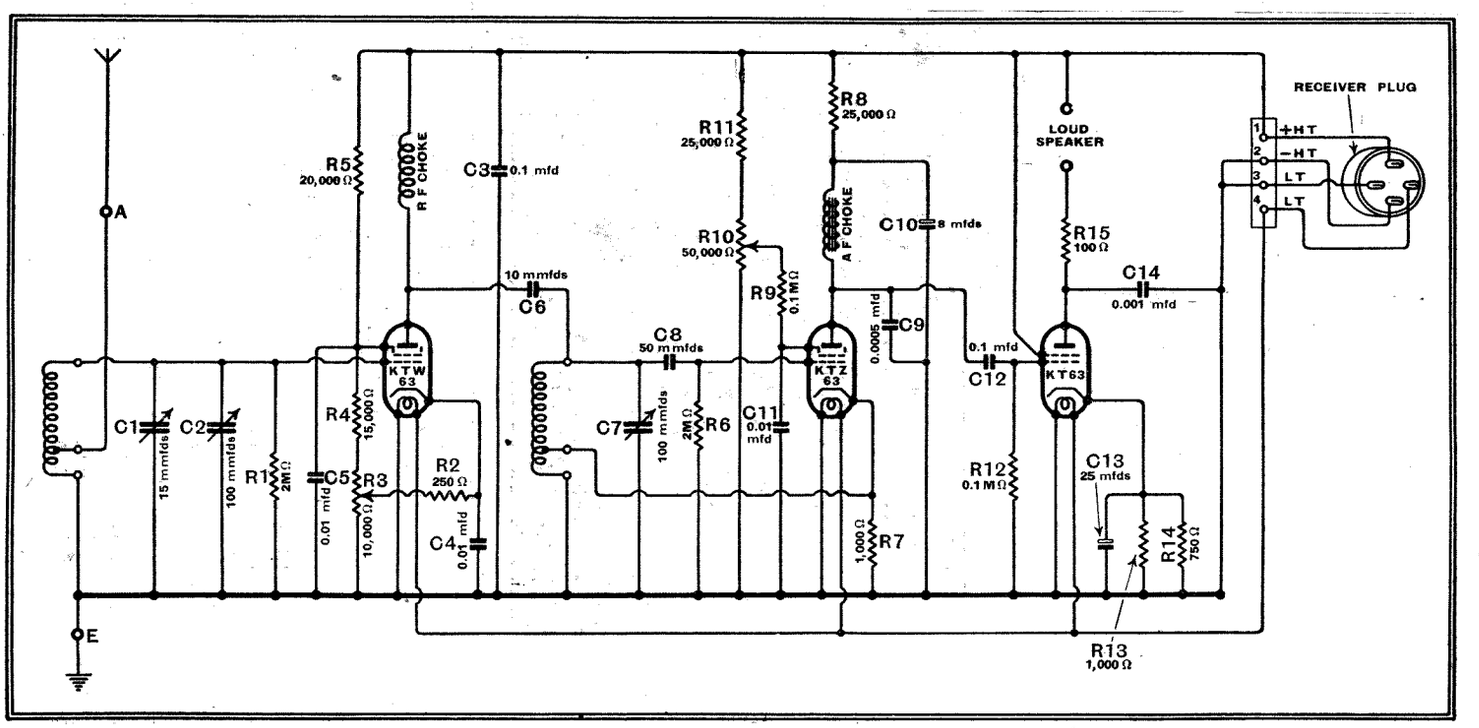
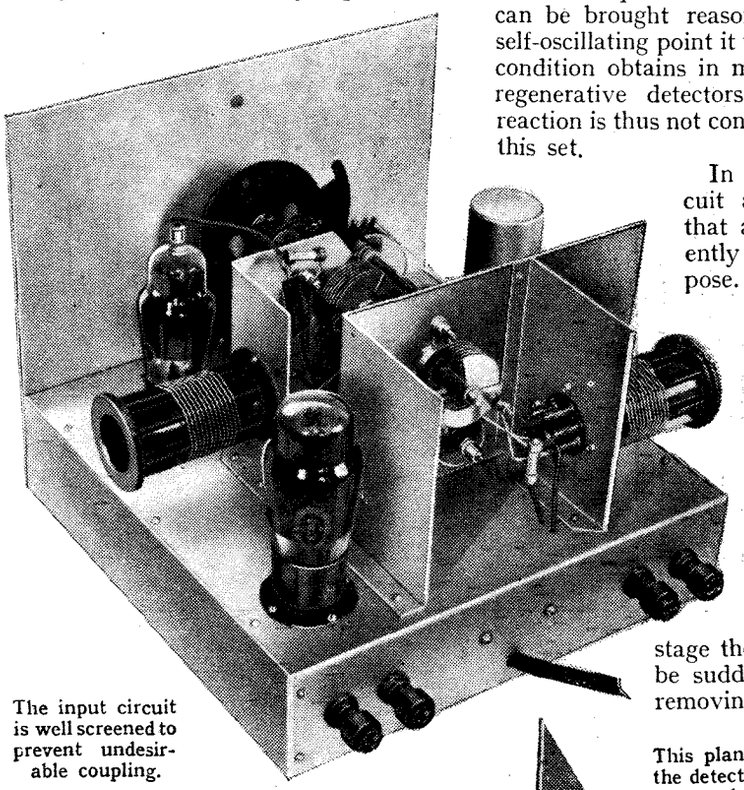



Fig. 1.—Theoretical circuit diagram of the short-wave receiver.

**AC Short-Wave Three—**

obtaining regeneration in the detector stage. No better scheme has so far been found than that of an RF tetrode or pentode valve with its cathode joined to a tapping on the coil and regeneration controlled by varying the screen potential of the valve.

This scheme has the least effect on the tuning and is far and away superior to a



The input circuit is well screened to prevent undesirable coupling.

triode with feed-back anode coil and capacity control of reaction. At least, this is the writer's opinion after making comparison tests with both kinds of detectors.

Choke-capacity coupling is used between the detector and output valves in order to obtain a sufficiently large signal input to the final stage, as the valve employed in this position requires about 12 volts RMS input to give its full output. Actually, quite a good loud-speaker signal can be obtained with only half this input. The choke must have a comparatively large inductance in view of the high AC resistance of the valve, and this is, perhaps, the only real disadvantage associated with the use of screened grid valves in a detector stage.

It has been possible to obtain about 200 henrys under working conditions by taking a Bulgin LF37 transformer and joining its primary and secondary windings in series. This transformer is not fitted with terminals, but has four leads coloured grey, yellow, red and green respectively. The series connection of primary and secondary is effected by joining together the grey and the green; the red is connected to the anode of the detector valve and the yellow goes to the decoupling resistance R8. By this means an adequate inductance has been obtained at a reasonable price.

The idea of applying regeneration to the RF stage was considered and some experiments actually made, but it did not seem to be very satisfactory.

When the detector is made to oscillate there is sufficient leakage through the RF valve to cause this stage almost to go into oscillation. Intentional regeneration thus only serves to produce actual oscillation in the RF valve and this is neither desirable nor required. Provided the RF stage can be brought reasonably close to the self-oscillating point it will suffice, and this condition obtains in most TRF sets with regenerative detectors. Intentional RF reaction is thus not considered necessary in this set.

In the theoretical circuit are two resistances that at first sight apparently serve no useful purpose. They are R1 and R7, in the RF and detector stages respectively. R1 prevents the grid of the RF valve being left "in the air" when the coil is withdrawn for wave-band changing. In the case of the detector stage the HT current would be suddenly interrupted on removing the coil and quite a high voltage might be developed across the anode choke which would be applied to the grid of the output valve; R7 prevents this taking place and only permits a relatively small change in current to occur.

Associated with the input circuit will be seen two tuning condensers, C1 of 15 m-mfds. and C2 of 100 m-mfds. The larger, C2, is ganged with C7, the RF circuit tuning condenser, and C1 is a panel-controlled trimmer for correcting discrepancies in the ganging at various parts of the range. It is difficult to see where these discrepancies arise, since the coils are space-wound and should be well matched; however, there were sufficiently large tuning errors observed to justify the inclusion of this trimming condenser.

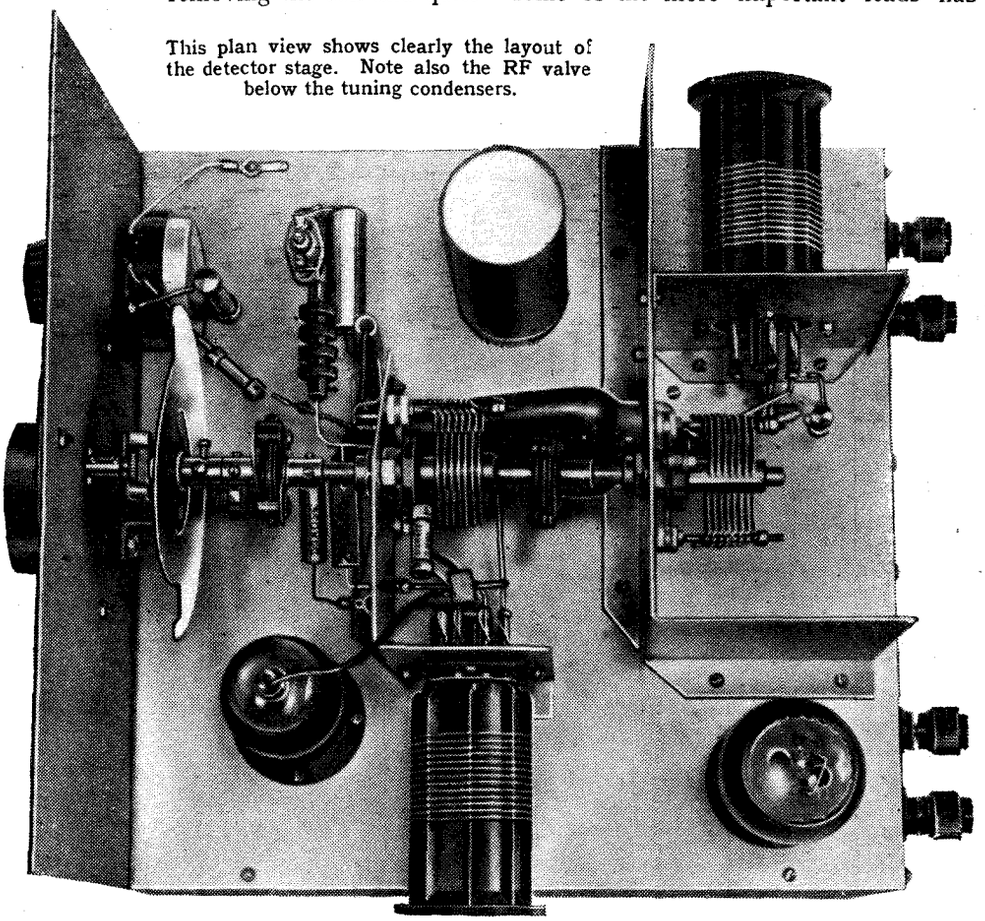
The stray capacity across the RF coil is a shade larger than that of the aerial, or input, circuit owing to the added anode-cathode capacity of the RF valve, and this just compensates for the minimum capacity of C1, so that a corresponding trimmer is not required in the RF circuit.

### Optimum Bias Resistance

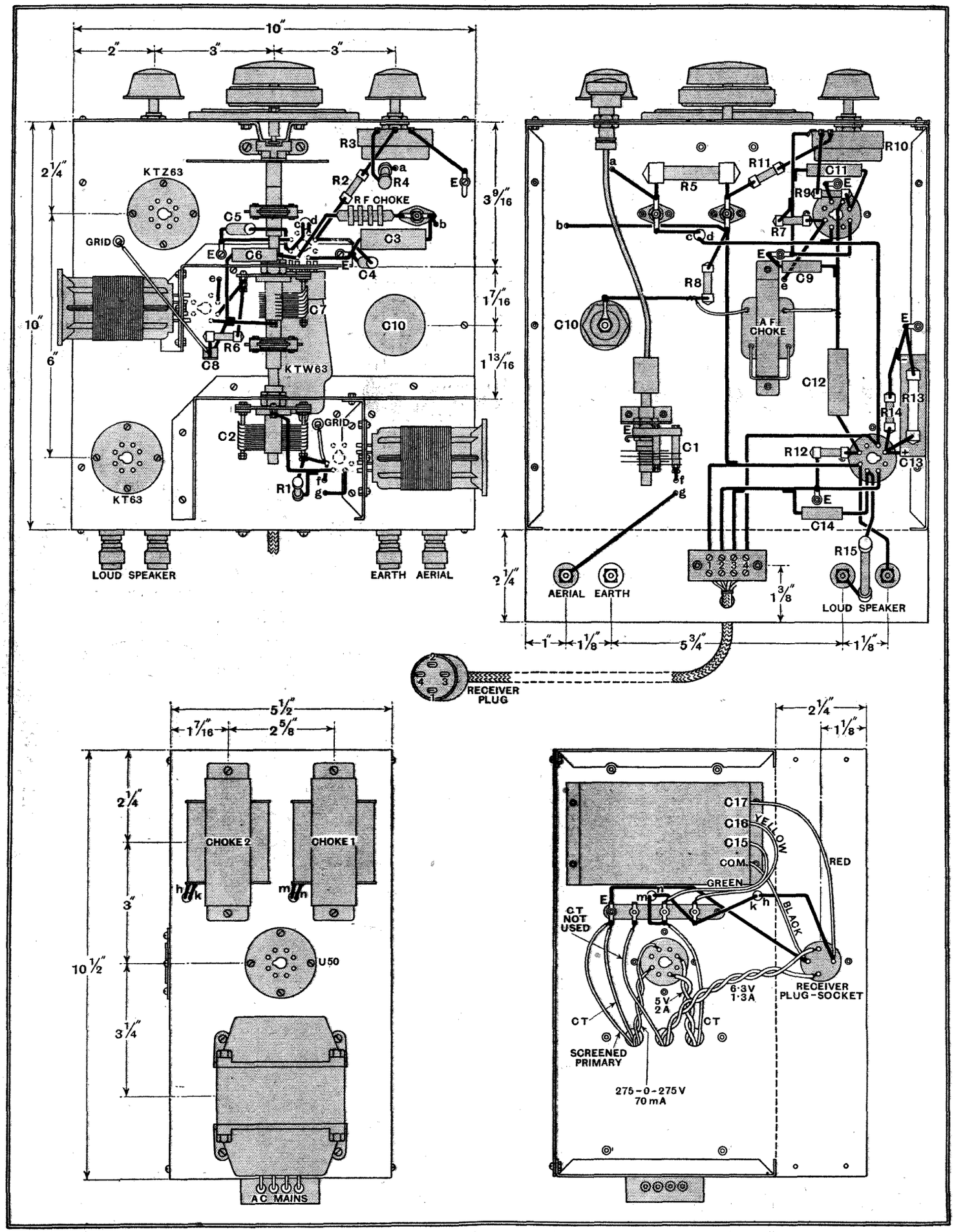
Before leaving this description of the circuit it might, perhaps, be advisable to explain the reason for two cathode bias resistances, R13 and R14, for the output valve. The optimum bias resistance for this valve is 420 ohms, a non-standard value, but which, however, can be obtained by joining one of 1,000 and one of 750 ohms in parallel.

The same general form of construction is adopted for this set as was used in the battery model. A slight shortening of some of the more important leads has been effected by moving the detector valve nearer the panel and by mounting the RF pentode below the tuning condensers.

This plan view shows clearly the layout of the detector stage. Note also the RF valve below the tuning condensers.



# ASSEMBLY AND WIRING DETAILS




Practical wiring plan of the receiver and power supply unit. This drawing also gives the exact position of all the components.

**AC Short-Wave Three—**

The AF volume control is omitted, as with a loud speaker all the necessary control can be effected by R3, at the input of the receiver, which in many respects is far more satisfactory in sets not equipped with AVC. Needless to say, AVC cannot very well be included in a set having a regeneration detector and which will be used largely in an oscillating state for heterodyne reception of CW signals and also when searching for weak stations.

There is very little that need be said about the construction of the set. It is quite straightforward and easily followed from the various illustrations and drawings. All parts are accessible, though it would be advisable to complete the wiring of the RF valveholder before assembling the front panel.

For operating this receiver an HT supply of 250 volts at about 65 mA. is required, while the LT consumption is 6.3 volts at 1.3 amps. An almost pure DC supply is essential, as if there is a trace of ripple on the HT voltage a troublesome hum will 'be audible in the loud speaker when regeneration is advanced to the point where the detector starts to oscillate. With this valve oscillating strongly the hum is not noticeable, nor is it heard with reaction backed off well below the oscillating point. This fact alone gives some indication of the sensitivity of the set when reaction is critically adjusted.

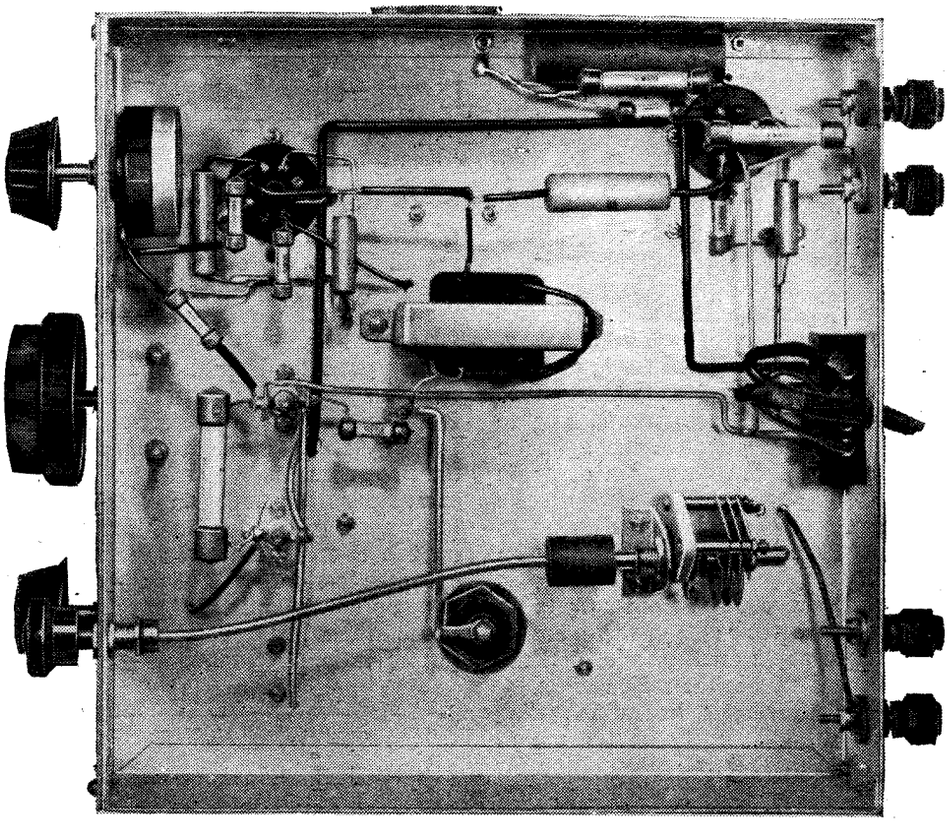
In order to obtain a ripple-free HT supply two smoothing chokes and two 8-mfd. condensers, in addition to the usual reservoir condenser of 4 mfds., have had to be used. Nothing less than this will suffice, but if the constructor already has a power pack giving the required output voltages it will only need the addition of one extra choke and a condenser to make it suitable for this set.

The three condensers, C15, C16 and C17, which are dry electrolytic, are contained in a single Dubilier unit which can be seen in the underside view of the power pack.

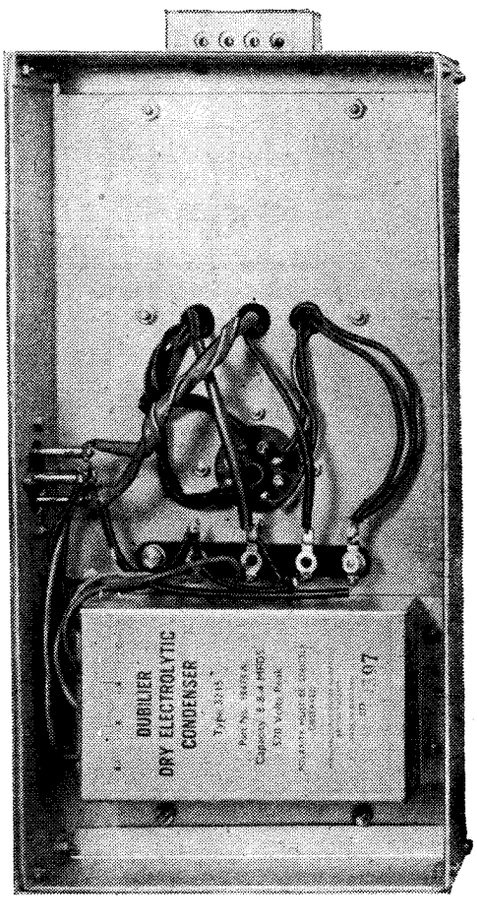
There now only remains the coils to discuss. Coils for four ranges covering 5.9 to 97 metres have been made, but there is no reason why the wave-range should not be extended to 200 metres if necessary. A tuning range of just over two to one can be obtained, so that one additional pair of coils will just carry the tuning up to the 200-metre mark. Since each coil has a single tapping only, they are comparatively simple to make, and the coil winding table gives all the necessary information.

It has to be remembered that the reference to the "earthy" end of the coil in this case relates to the top and not to the bottom of the coil as is the more usual practice. Making the top of the coil, the "earthy" end was adopted because the coils being mounted horizontally brings this end of the formers adjacent to the outside edges of the chassis, and if it is housed in a metal cabinet the low-potential ends of the coils then fall adjacent to the metal work.

Examination of the illustration will reveal that the ends of the coil formers slightly overhang the chassis. This has been done to facilitate coil changing when the set is housed in a cabinet, as large holes can be cut in the sides at appropriate places through which the coils can be inserted. The B.T.S. former has a self-locating centre spigot which greatly facilitates coil changing and is the reason



The underside view of the receiver chassis. Note the method of mounting the aerial trimmer condenser C1, which is operated by a flexible cable.




A single condenser block below the chassis contains the three electrolytic condensers, C15, C16 and C17.

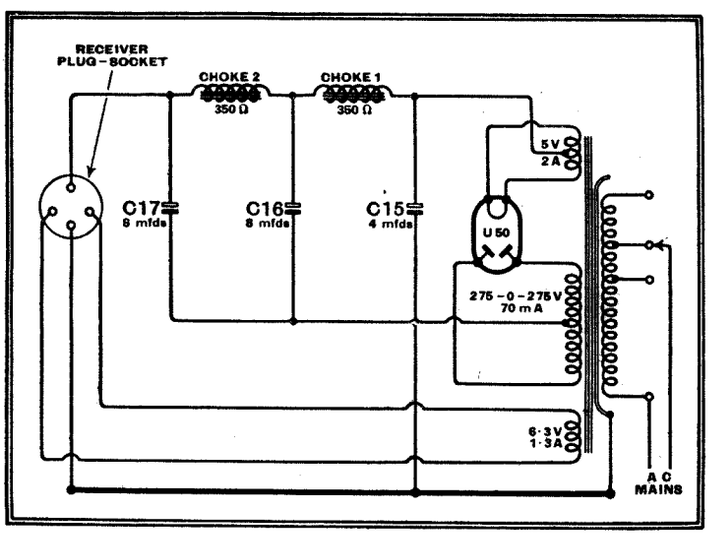
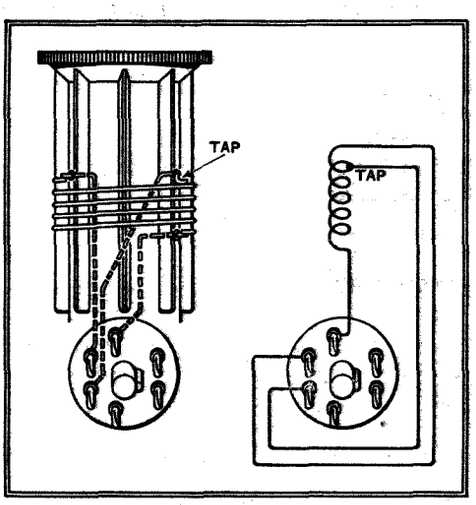



Fig. 2.—Theoretical circuit of the power supply unit. Condensers C15, C16 and C17 are contained in a single unit with a common negative connection.

**AC Short-Wave Three—**

why a six-pin former is used for each coil even though only three pins are required.

The two coils for each range have the same number of turns, and the only difference between the input, or aerial, coil and the RF (detector) coil is in the position of the tapping. It was not found practicable in this set to use the same coil in both positions, and consequently some distinctive marking ought to be made on the coils to prevent inadvertently changing them over. Actually no damage will be done if they are reversed; fierce reaction and poor signal strength only will result.




**All coils are wound and connected to the pins in the same manner. This is a typical example.**

Range 1, covering 5.9 to 12.8 metres, takes in the television wavelengths, tuning in the sound transmitter on 7.23 metres at 21 on the condenser scale, and also the 10-meter amateur band which falls between 50 and 60 on the dial.

The next range, having a coverage of 10.5 to 23 metres, covers the 13-, 16- and 19-metre broadcast bands as well as the 20-metre amateur band. The three broadcast bands will be found centred about 27, 46 and 67 on the dial, while the amateurs will be found at 79 on the scale.

With range 3 the coverage is 22.3 to 48 metres, which produces the 25-metre broadcast stations in the region of 14 on the dial and 31-metre stations at a scale reading of 33. The amateurs on 41 to 42 metres tune in between 66 and 74 on the dial.

The next range tunes from 45.4 to 97 metres, which gives us the 50-metre broadcast stations at 12 on the scale, and the 80-metre amateurs in the region of 61.

As with all TRF sets, its station-getting properties depend largely on the use of reaction, the most sensitive condition for broadcast reception being when the detector valve is just on the brink of oscillation. When adjusting the aerial circuit trimmer C1, the reaction control R10 should be backed off to below the oscillating point, as it is difficult to judge when the circuits are correctly in tune with the set oscillating.

Any good loud speaker may be used with this set, and as no provision is made for obtaining field excitation, it might, perhaps, be advisable to employ one of the permanent magnet variety. All loud speakers now include an output transformer, so, of course, there is no need to include this component in the set. The optimum load for the KT63 output tetrode is 7,000 ohms, and this figure should be borne in mind when calculating the transformer ratio.

**COIL WINDING TABLE.**

| Range. | Waveband (metres). | Turns. | Wire. | Spacing. | Tapping on Aerial Coil. | Tapping on Detector Coil. |
|---|---|---|---|---|---|---|
| 1 | 5.9—12.8 | 2 | No. 18 SWG | 8 t.p.i. | $\frac{1}{8}$th turn | $\frac{1}{8}$th turn |
| 2 | 10.5—23 | $4\frac{5}{8}$ | No. 18 SWG | 8 t.p.i. | 1 turn | $\frac{3}{16}$th turn |
| 3 | 22.3—48 | $12\frac{1}{2}$ | No. 20 SWG | 12 t.p.i. | $1\frac{1}{2}$ turns | $\frac{1}{4}$ turn |
| 4 | 45.4—97 | 27 | No. 24 SWG (enamel) | 22 t.p.i. | 4 turns | $\frac{1}{2}$ turn |

**Note.**—The tappings are measured from the "earthy" end of the coil which in these is the top of the coil former.

## LIST OF PARTS

**RECEIVER**

**1 Variable condenser,** 15 mmfds., **C1** — **Webb's "Apex"**
**2 Variable condensers,** 100 mmfds., **C2, C7** — **Eddystone "Microdensers" 1130**
**1 Dial,** full vision, dual speed — **Eddystone 1070**
**2 Flexible couplers** — **Eddystone 1009**
**1 Short-wave RF choke** — **Eddystone 1010**
**1 AF transformer** — **Bulgin LF37**
**1 Flexible driving shaft** — **Eddystone 1096**
**3 Stand-off insulators** — **Eddystone 1019**
**3 Valve holders,** octal type — **Premier Supply Stores**

**Resistances:**

1 250 ohms, ½ watt, **R2** — **Dubilier F½**
1 750 ohms, ½ watt, **R14** — **Dubilier F½**
1 1,000 ohms, ½ watt, **R7** — **Dubilier F½**
2 25,000 ohms, ½ watt, **R8, R11** — **Dubilier F½**
2 100,000 ohms, ½ watt, **R9, R12** — **Dubilier F½**
2 2 megohms, ½ watt, **R1, R6** — **Dubilier F½**
1 100 ohms, 1 watt, **R15** — **Dubilier F1**
1 1,000 ohms, 1 watt, **R13** — **Dubilier F1**
1 15,000 ohms, 1 watt, **R4** — **Dubilier F1**
1 20,000 ohms, 2 watts, **R5** — **Dubilier F2**

**1 Potentiometer,** 10,000 ohms, wire wound, **R3** — **Reliance TW**
**1 Potentiometer,** 50,000 ohms, wire-wound, **R10** — **Reliance TW**

**Fixed condensers:**

1 0.0005 mfd., tubular, **C9** — **Polar-NSF**
1 0.001 mfd., tubular, **C14** — **Polar-NSF**
3 0.01 mfd., tubular, **C4, C5, C11** — **Polar-NSF**
2 0.1 mfd., tubular, **C3, C12** — **Polar-NSF**
1 10 mmfds., mica, **C6** — **Bulgin CM2**
1 50 mmfds., mica, **C8** — **Bulgin CM3**
1 25 mfds., 25 volts, electrolytic, **C13** — **Bulgin EC4**
1 8 mfds., 500 volts working, electrolytic, **C10** — **Dubilier 0281**

**2 Six-pin self-locating coil bases** — **B.T.S.**
**4 Six-pin self-locating coil formers,** threaded 8 t.p.i. — **B.T.S.**
**2 Six-pin self-locating coil formers,** threaded 12 t.p.i. — **B.T.S.**
**2 Six-pin self-locating coil formers,** threaded 22 t.p.i. — **B.T.S.**
**1 Knob** — **Bulgin K14**
**4 Terminals,** ebonite shrouded, A, E, LS(2) — **Belling-Lee "B"**
**1 Connector,** 4-way — **Bryce 5C2**
**2 Plug-top connectors,** octal type — **Bulgin P96**
**1 4-way cable and plug** — **Goltone**
**Miscellaneous:** — **Peto-Scott**
Aluminium for chassis, 10×10×2¼in.; aluminium for panel, 10×8½in.; aluminium for screens, 10×5in., 6×4½in., 5×3⅜in.; 3 lengths Systoflex; 4 oz. No. 20 tinned copper wire; small quantity No. 18 tinned copper wire and 24 enamelled wire; screws, etc.

**Valves:**

1 KTW63, 1 KTZ63, 1 KT63 — **Osram**

**POWER PACK**

**1 Mains transformer,** with screened primary, 275-0-275 volts 70 mA., 6.3 volts 1.3 amps., 5 volts 2 amps., C.T. — **Vortexion S275**
**2 Smoothing chokes,** 30 H., 80 mA., 350 ohms DC resistance — **Premier Supply Stores**
**1 Condenser,** 8-8-4 mfds., 570 volts peak, electrolytic, **C17, C16, C15** — **Dubilier 3215RB**
**1 Valve holder,** 4 pin (without terminals) — **Clix Chassis Mounting Standard Type VI**
**1 Valve holder,** octal type — **Premier Supply Stores**
**1 Connector,** 4-way — **Bryce 5C2**
**Miscellaneous:** — **Peto-Scott**
Aluminium for chassis, 10½×5½×2¼in.; 1 oz. No. 20 tinned copper wire; length Systoflex, screws, etc.

**Valves:**

1 U50 — **Osram**

# News from the Clubs

### *Exeter and District Wireless Society*

**Headquarters:** Y.W.C.A., 3, Dix's Field, Southernhay, Exeter.
**Meetings:** Mondays at 8 p.m.
**Hon. Sec.:** Mr. W. J. Ching, 9, Sivell Place, Heavitree, Exeter.

At his lecture on September 26th, Mr H. A. Bartlett emphasised the amount of research work which amateurs are doing on the ultra-high frequencies. Mr. Bartlett then gave a display of films lent by the R.S.G.B. illustrating many well-known London amateur transmitting stations and also events in the Annual National Field Day Competition.

### *North Manchester Radio Society*

**Headquarters:** 14, Fairfax Road, Prestwich, nr. Manchester.
**Hon. Sec.:** Mr. R. Lawton, 10, Dalton Avenue, Thatch Leach Lane, Whitefield, nr. Manchester.

Readers who visited the Manchester Radio Exhibition, which will be open until Saturday night, are invited to call at the Society's stand (No 5), where a collection of short-wave amateur transmitting and receiving gear is being shown. Full details of the Society's activities can be obtained at the stand.

### *Dollis Hill Radio Communication Society*

**Headquarters:** Braintcroft Schools, Warren Road, London, N.W.2.
**Meetings:** Alternate Tuesdays at 8.15 p.m.
**Hon. Sec.:** Mr. E. Eldridge, 79, Oxgate Gardens, London, N.W.2.

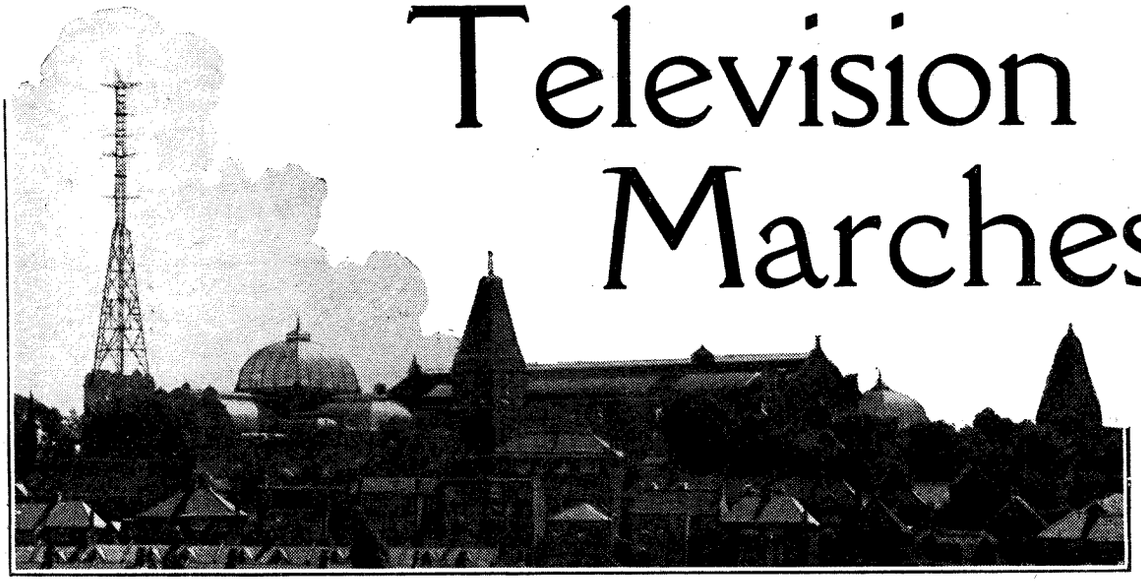
The September 20th meeting was devoted to set-repairing and fault-tracing. On October 18th, a lecture entitled "Interference Suppression" will be given by a representative of Belling and Lee, and on November 1st Mr. D. N. Corfield will lecture on "The Alignment of Superhets."

### *Ashton and District Amateur Radio Society*

**Hon. Sec.:** Mr. K. Gooding, 7, Broadbent Avenue, Ashton-under-Lyne, Lancs.

At the meeting on September 21st Mr. W. T. Green demonstrated his 56-megacycle gear. This was followed by a discussion on the various types of ultra-short wave receivers. Morse classes are now held every Monday and Friday at the Commercial Hotel, Old Street, Ashton-under-Lyne. The Society's membership now totals 27.

# Television Marches On



By "MUSWELL HILL"

## Studio Developments at Alexandra Palace

IN the comparatively vast studio which the Radio Manufacturers' Association erected at Radiolympia, the B.B.C. Television staff enjoyed elbow room, and plenty of it, for the first time in their hectic careers. It was like taking a canoe into the Atlantic Ocean after manœuvring the Queen Mary in Southampton Docks. Cameras could be tracked back, and then back, without the risk of a conductor's baton impinging on a camera man's devoted head. Microphones could be moved and swung around without nerve-racking efforts to avoid collision with people, cameras, cables and lamps. In a word, there was freedom to move, and the television pictures gained immeasurably in consequence. Having revelled in these wide open spaces, the staff will never really be happy again until the conditions are repeated in the super television studio of the future. Sooner or later such a studio must come—something which offers the lavish scenic opportunities of Hollywood or Denham, coupled with facilities for the immediate and continuous presentation peculiar to broadcasting and television.

### The Two-studio System

The first step in this direction was taken on August 21st when the new central control room was opened at Alexandra Palace. Equipped to take sound and vision outputs from a variety of sources, this nerve centre of the organisation will have its first severe test by the middle of this month when Studios A and B are both in operation as independent units. Each studio has its own local control gallery for the producer's use, with vision and sound mixers. From these the producers watch the action on the floor and control the presentation on twin monitor tubes on the principle adopted in Studio A since the opening of the service. But the Studio A control gallery, until recently, has been saddled with additional technical functions which turned the life of the television producer into one long nightmare. Preoccupied with his own programme, the producer was surrounded by a host of hard-working technicians concerned with tests on other circuits, pictures from the mobile unit, signals from Broadcasting House, telephone calls from the transmitter hall, and a hundred and one other distractions.

All this has now been changed with the introduction of the central control room, which co-ordinates the work at a point remote from the producer's gallery; the producer, taking his starting cue from the central control room, can now give his undivided attention to the performance in the studio.

An improvement of some importance in the newly equipped Studio B (formerly used for the Baird system) is the housing of the producer's control unit in a raised bay midway along one side of the studio. The producer is thus very much nearer the stages than in Studio A, where the control gallery is still situated high up at the far end behind the orchestra.

*ALTHOUGH television programmes, being designed for fireside audiences rather than for mass appeal, may never require the grandiose production methods of the film, they are bound to be improved by the new studio facilities at Alexandra Palace, described in this article.*

Occasionally, for major productions, the two studios may be used together, but the intention as far as possible is to keep them distinct. so that camera rehearsals can proceed in one while transmission is going on in the other. In addition to the outputs from the studios, the central control room handles incoming signals from the mobile radio unit, those emanating from the balanced television cable linking Alexandra Palace with Central London, pictures and sound from the telecine plant, and gramophone records. In the not far distant future it may also be coping with the camera and sound channels from the reconstructed Alexandra Palace theatre.

It is this last-mentioned development which has naturally excited most attention in the last few weeks, for here we have more than a hint of the way in which television production is likely to develop.

### Almost on the Hollywood Scale

That the old theatre attached to Alexandra Palace should be used for television programmes has been envisaged from the start, but up till now it has been used for practically everything but entertainment. Occasional rehearsals have been carried out on the draughty stage, and the dressing rooms have long since been commandeered as offices for the overcrowded staff. The auditorium, foyer and adjoining apartments have been gratefully taken over by the stage carpenters, "property" men and scene painters, most of whom will have to find another home when the work of reconstruction begins in the next month or two.

The theatre is a large one, measuring 140 feet by 60 feet, and making possible the development of a scheme which is growing in favour as the ideal for television presentation, i.e., the use of a producer's control tower centrally placed with a radial arrangement of sets. According to present plans, provision will be made for at least five sets, including the existing stage, but room can be found for a large number of set-ups of the "grotto" type in which only one or two artists appear in short scenes or conversational interludes. The producer's control unit, accommodating

**Television Marches On—**

sound and vision mixing engineers and other technical operators, will be in the form of a tiered structure giving a clear view of the whole floor and all the sets. Easy access between sets will enable artists to pass from one scene to another with a minimum of delay—a consideration which does not trouble film directors but is of first-class importance in television.

Arranged on the "expanding bookcase" principle, the central control room will be able to take the output from the theatre, combine it, if necessary, with film excerpts from the telecine room, interpolate a scene from Alexandra Park or even from a mobile television unit, and weld the whole into one production. The tendency, however, is to discourage unnecessary multiplication of programme sources. The engineers in the central control room would not wilt if a "super" two mobile units and a hundred actors at his finger-tips, all controlled by half a dozen knobs, but if the same effect can be produced on the viewer's screen by more economical methods, those methods will be used, and the money saved devoted to fresh programme material.

Although the theatre scheme has yet to be finally approved, programme presentation should improve perceptibly from week to week. The bane of television production up till now has been the lack of time for adequate camera rehearsals. With only four available camera channels the ratio of camera rehearsal time to transmission time has rarely been more than 2 : 1, and has often been less. With the use of two studios the gain will be immediate. Facilities for adequate lighting will be improved and artists will be given a fair chance to acquaint themselves with the camera positions without the feverish haste which has already spoilt so many grammes will still be designed not for mass appeal but for the viewer and his family at home. But in their own sphere they will approach that technical *finesse* which one looks for on the stage and screen and which, even in these pioneer days, is often insinuated into the programmes from Alexandra Palace.

It is proposed that the old theatre at Alexandra Palace, the auditorium of which is at present used mainly by stage carpenters and property men, should be converted into a super television studio, with a central producer's tower surrounded by radial "sets"

production called for the simultaneous use of the theatre and Studios A and B, but complications of this kind would not be introduced merely to satisfy the urge for virtuosity. It may gratify a producer's "power complex" to have fifteen stages, finely conceived programmes transmitted from Alexandra Palace.

With the completion of the theatre scheme, television production will enter upon a new phase. It will not, perhaps, rival the film or the theatre, for the pro-

## The Wireless Industry

A GREAT deal of useful information about the properties of the newer alloys (Alnico and Alni) used for permanent magnets is contained in a catalogue issued by Darwins, Ltd., Fitzwilliam Works, Sheffield. The magnetic properties of cobalt, tungsten and chromium steels are also discussed.

◈ ◈ ◈ ◈

Changes of address: Wingrove and Rogers, Ltd. (London office), to 12, Dartmouth Street, London, S.W.1. Telephone: Abbey 2272-3. Reliance Manufacturing Co. (Southwark), Ltd., to Sutherland Road, Higham Hill, Walthamstow, E.17. Telephone: Larkswood 3245.

◈ ◈ ◈ ◈

Owing to the demand for Belling-Lee "Skyrod" aerials for A.R.P. installations, there has been some delay in delivery, for which the makers express regret.

***How a Receiver is Designed.—XXVI.***

# Designing an All-wave Battery Set

*A RECEIVER for battery operation differs in several ways from a mains set because of the imperative need for economy in operating power. The design must consequently proceed on rather different lines and in this article the details are discussed.*

THE design of a battery set is carried out in the same way as in the case of mains-operated apparatus, but it is much more difficult to secure an equivalent performance. This is because it is usually very uneconomical to supply the set with the same power. Watt for watt, power is very much more expensive when it is obtained from batteries than when the mains are used.

Economy of power consumption is hardly considered in the design of mains-operated receivers, for it is in any case so small that running costs are not important. Only in the case of large amplifiers, with which the consumption may reach several hundred watts, does economy begin to be important.

With battery-operated apparatus economy is always important, and is achieved as far as possible by avoiding waste. Directly heated valves are used, for they require less filament power than indirectly heated types, and the use of potentiometers across the HT supply is avoided wherever possible. Battery valves, too, are usually designed to operate at a lower anode voltage and to consume a lower anode current than mains types. This economy is, however, obtained at the expense of performance, for the valves have lower values of mutual conductance than their mains counterparts, with the result that less amplification is obtained per stage.

This in itself is not a serious drawback. Amplification is fairly easy to obtain, and it often happens that more gain can be secured from two stages than from one with the two stages operated so that together they consume less power than one. This course involves an increase in first cost, however, so that it can only be adopted occasionally.

In the early stages of a battery receiver it is not unduly difficult to secure the required amplification for a reasonable power consumption, and the chief inconvenience lies in having to use directly heated valves. This makes the attainment of the correct grid bias voltages more difficult than it is with indirectly heated valves. The difficulties involved, however, can be relieved to some extent by using an indirectly heated valve for the diode detector. This is permissible because the emission needed is so low that an indirectly heated cathode can be used and the heater power can still remain small.

It is in the output stage that the chief difficulties arise, and it is here that the chief sacrifice in performance must be made to secure economy. The loud speaker requires power to operate it, and this power can only come from the HT battery. The efficiency of the output stage is fairly low, and it often happens that the total power consumption of a battery set is expected to be no more than the audio-frequency power output of a mains set. In such a case the battery set must deliver less volume than the mains receiver and normally at a lower level of quality.

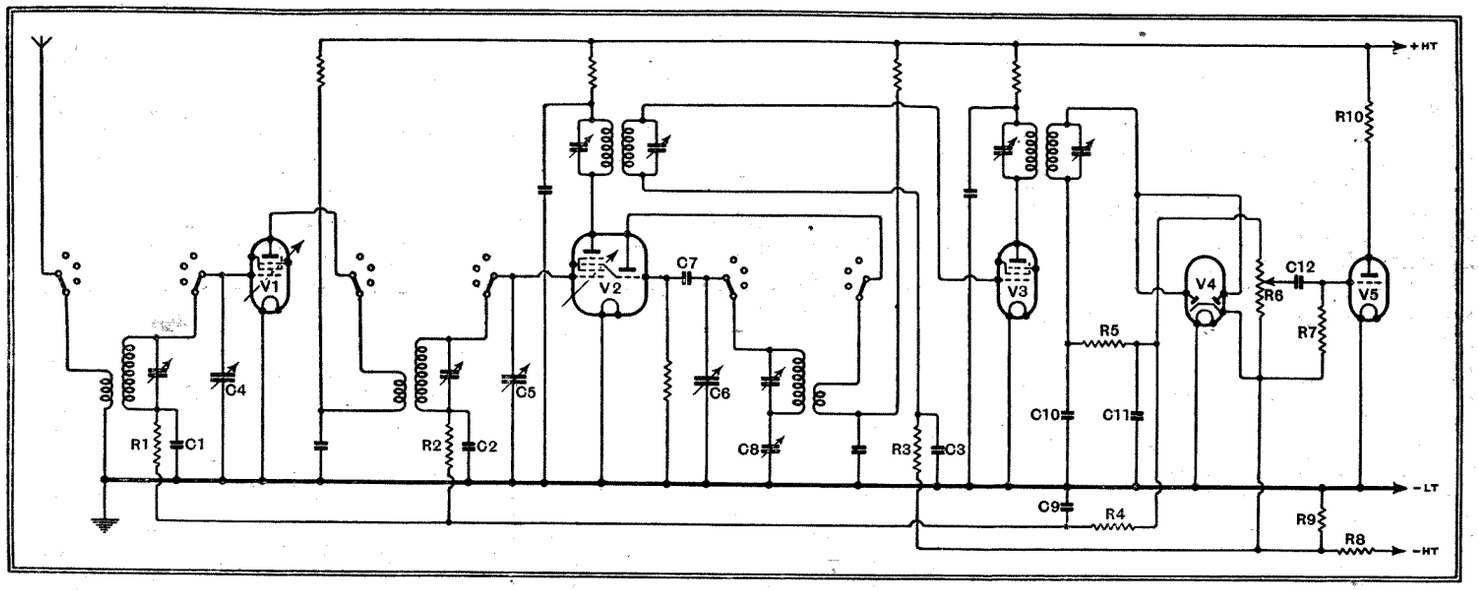



Fig. 1.—The tentative circuit of the early stages of an all-wave battery superheterodyne is given here.

## General Characteristics

When designing a receiver it is usual to start at the output stage and work backwards to the beginning, and this is undoubtedly the right course to adopt when either the output required or the maximum permissible anode current for the output stage is known. With a battery set, however, the requirement is usually to obtain as much output as possible for a total current consumption from the HT supply of perhaps 15 mA. only. If the output stage is designed first, we shall be likely to find that we have allotted to it an excessive proportion of the current so that we are left with too little for the early stages. If we design the early stages first, however, we are likely to do the converse and leave too little current for the output stage. Nevertheless, it does in practice seem better to adopt this latter course, because the errors usually work out smaller.

The receiver must, of course, cover the medium and long wavebands, and on short waves it will meet most requirements if it tunes from about 13 metres to 70 metres. This is too great a range to obtain in one band, so that two short-wave ranges will be needed and the coverage can then be

**Designing an All-Wave Battery Set—**

somewhat greater than is indicated above.

To secure a good signal-noise ratio an RF stage will be needed before the frequency-changer, for the receiver will naturally be a superheterodyne to secure high selectivity on short waves. We must have one IF stage for good sensitivity and a diode detector for AVC. An AF stage will be needed before the output stage so that the latter can be fully loaded on the weaker signals.

In general form, therefore, the receiver will consist of one RF stage, frequency-changer, one IF stage, diode detector, one AF stage, and output stage. The RF and IF valves will naturally be RF tetrodes or pentodes and the AF valve a triode. The frequency-changer is more difficult. We can rule out heptodes and octodes on account of the pulling difficulties which arise on short waves, and also because the mutual conductance of the oscillator section is likely to be too small for reliable operation on short waves, especially if we use standard coils.

The alternatives consist of the triode-hexode on the one hand and a two-valve frequency-changer—consisting of hexode mixer and triode oscillator—on the other. The triode-hexode is at first sight the more attractive, but until we have tried it we cannot say whether it will be satisfactory or not with standard coils.

This emphasis is laid upon standard coils because it so happens that there is a range available which give just the required waveband coverage, and standard coils are usually cheaper than special ones. This range is the Wearite "P" series, and with the usual 0.0005 $\mu$F. variable condenser bands of approximately 12-35, 34-100, 200-557, and 700-2,000 metres can be covered, which is just what we want.

Their suitability for our purpose depends largely upon the valves, however, and can only be settled definitely by a practical trial. Our first step, therefore, is to sketch out the circuit of the early stages, and this is shown in Fig. 1. For clarity only one set of coils is shown since the connections for the other ranges are the same.

The three-gang tuning condenser is represented by C4, C5, and C6, while the trimmer C8 is the oscillator padding condenser. The signal-frequency circuits are completed through C1 and C2 for the aerial and intervalve circuits respectively, and both AVC and initial grid bias are applied through the resistances R1 and R2.

### Grid Bias

It is here that one of the differences between a battery and a mains set becomes evident. With indirectly heated valves the initial negative grid bias would be secured by biasing the cathodes positively with respect to the earth line, and only AVC bias would be applied through R1 and R2. With directly heated valves both are applied from the same line and the initial bias of all valves controlled from the AVC system must normally be the same.

The AVC line must be returned through the various filter and diode resistances to a point negative with respect to the earth line by the amount of the initial bias required. Using a directly heated diode or duo-diode-triode we can then only operate with delayed AVC and with the amount of delay equal to the initial bias. This arrangement is shown in Fig. 2, and is undesirable since delayed AVC is liable to introduce distortion.

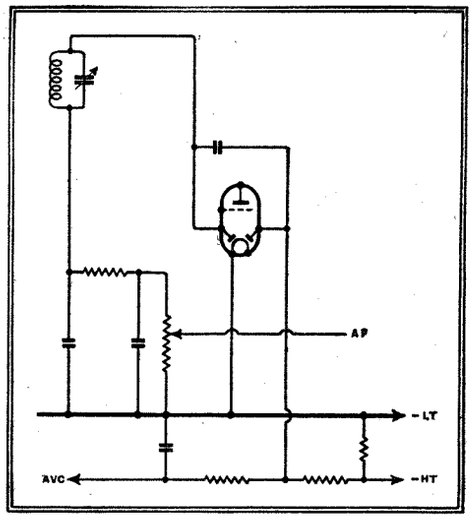



**Fig. 2.—This diagram shows the use of a duo-diode-triode. A delay on AVC cannot readily be avoided.**

Of course, it is possible to overcome this drawback by arranging the circuit for zero bias and then including a bias battery in the AVC line. This course, however, is usually considered objectionable, and nowadays automatic bias is demanded. This is obtained in Fig. 1 by the resistance R9 in the negative HT lead, and it will be seen that the use of an indirectly heated diode overcomes the bias difficulty, for the cathode need not be returned to the earth line but to the negative bias line.

It may be remarked at this point that the use of automatic grid bias makes the use of an output stage with a large fluctuating anode current undesirable. Such stages are the QPP and Class B types, but these are often undesirable from other points of view.

The value of grid bias needed can hardly be determined without trial. For maximum sensitivity it should be as small as possible, but the HT current is greatly reduced by an increase of bias. We must determine the bias experimentally, therefore, to give a good compromise between the conflicting factors of sensitivity and economy. The IF transformers will naturally be chosen to have a high dynamic resistance so that high gain can be secured with a moderate mutual conductance and, hence, anode current.

In this connection it should be remembered that when the set is tuned to a signal AVC will bias back the first two valves and reduce their consumption. We can, therefore, afford to make their currents rather higher than would otherwise be the case.

*The purpose of this series of articles is to help the amateur to understand the problems that arise in designing new receivers and to be of aid to those who desire to construct their own sets. A further article on the All-Wave Battery Set will be included in an early issue, to be followed by a full description of a practical receiver with constructional data.*

# Random Radiations

## By "DIALLIST"

### Their Just Due

THERE are those (I have come across some of them myself) who metaphorically foam at the mouth when they read of the sums that the B.B.C. pays out each year to the Performing Right Society. Such folk have the idea that the composer who asks for a fee for a performance of one of his works is staging some kind of ramp; and they regard the Performing Right Society, which helps the composer to obtain his due, as some sort of rapacious ogre. Actually, there is no ramp on the part of the composer and the Society is neither rapacious nor an ogre. A composer has to live, and the only way in which he can earn a livelihood is by the receipt of fees—and very modest fees they are as a rule—for performances of his works. The copyright of those works belongs to him just as much as any of our possessions belong to you or to me. Clearly it would be grossly unfair if use were made of a composer's property without there being payment in return for the work that he has done to create it.

### Authors, Too

Similar considerations apply to the broadcasting of plays, stories, and so on. Unless the author has disposed of the copyright it belongs to him; and his writings, like the composer's works, are his own property. When a play is performed or a story read the author naturally expects some payment for the use of a part of his stock-in-trade. To small users the fees charged by both authors and composers are modest; it is only natural that they should be higher when the audience may run into millions. It is pretty hard on those who do creative work if the children of their brain are simply filched. I write perhaps with some feeling on this subject. The United States stands alone amongst civilised countries in legalising the filching of work published outside her own borders. Recently an American paper "lifted" a copyright article of mine, lock, stock and barrel, published it under splash headlines, and made it the chief feature of one issue. They haven't paid me a penny for it and I can't make them do so.

### Across the Atlantic and Back

IT was from America on the short waves that I heard Hitler's Nuremberg and Berlin speeches. You may wonder why I chose a short-wave channel which involved the crossing of the Atlantic in both directions instead of tuning in Berlin or Leipzig or Stuttgart direct on the medium waves.

**Random Radiations—**

The reason is, quite simply, that I can't follow German unless it is spoken slowly; once a speaker begins to get worked up and to loose a spate of words I'm out of my depth. The speeches were relayed in America by the National Broadcasting Company and sent out over the short waves as well. At every pause, and during each outburst of applause, a commentator broke in to give either a translation into English of what had just been said, or the gist of the passage if it happened to be a long one. I commend the idea to the B.B.C.

## Interference in London

A LONDON reader tackles me about the statement I made not long ago in these notes that a fairly high aerial of the anti-interference kind appeared to be able to defeat car-ignition interference in central London. He tells me that in his locality "there are no wires of any kind to re-radiate interference"; yet an expensive anti-static aerial, 60 feet above the level of the road, cuts down ignition interference by some 50 per cent. only. He mentions, by the way, that he finds Post Office vans by far the worst offenders. What have the G.P.O. people to say about this? My statement about the freedom from interference produced by aerials from 60 feet to 100 feet above the streets was based on information given to me by a reader who had been engaged in installing interference-free reception arrangements in many parts of London. Possibly the present case is one of those difficult ones in which re-radiation is taking place from some quite unexpected source.

## Nocturnal Noise

THOUGH I didn't see it myself I am told that a report appeared recently in one of the papers that an over-loud loud-speaker was most effectively silenced by strong, if somewhat irregular action on the part of those afflicted by its strains. The owner of the instrument liked his music loud and he liked it late at night. To his neighbours neither of these things appealed. Protests having produced no results, they visited him *en masse* and treated him to something rather more concrete than a piece of their mind. I have been feeling rather the same way myself lately and had it not been that I was on the point of moving to another house, I might have formed a kind of Ku Klux Klan and led a band of co-sufferers to wreak vengeance. The loud-speaker in question was a couple of hundred yards from me, but it filled my house with noise at all hours of the night.

## A Suggestion

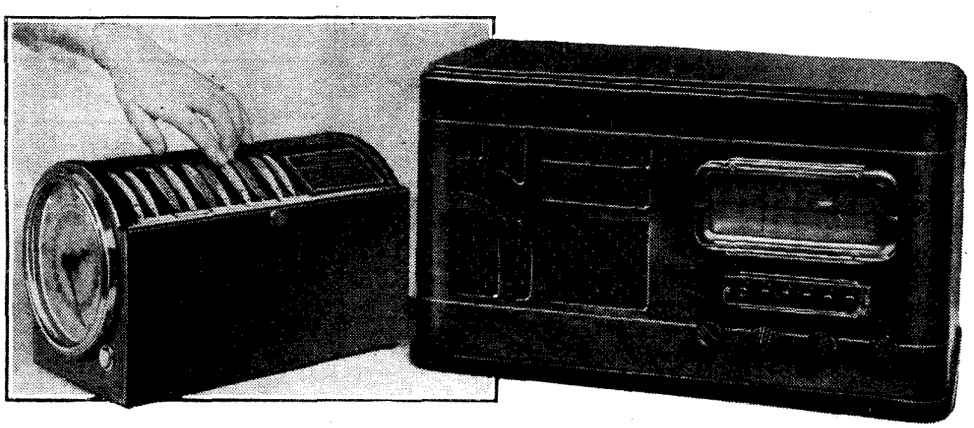
Many people, I believe, cause annoyance to their neighbours by means of their loud-speakers without in the least realising that they are doing so. In fact, the man or the woman who would disturb other people in this way deliberately is, fortunately, a very rare being. If you are not sure whether or not your own loud speaker worries other people when you are operating it at normal volume late at night, here's a way of finding out. Switch on the set, leave it at work and take a walk outside. If you find that you can hear it pretty strongly when you are at your next-door neighbour's gate, then the odds are that you're not exactly adding to the joy of his life, even though he may have said nothing about it.

## Not Too Easy

SOME time ago I told you that I had had a letter from Mr. E. S. Darlington, who is in charge of W2XAD and W2XAF, written whilst he was expecting at any moment the men who were coming to move his office to a new building some distance away. I am writing this under much the same conditions. I am left with a table and a chair standing on the bare boards, and before long the hefty fellows who are juggling with pianos and wardrobes and things will insist upon carting even these away. I can see that I shall probably have to finish these notes sitting on one packing case and using another as a table.

## Sorting Out

Until I came to sort out the wireless bits and pieces representing the accumulations of some twenty years, I had no idea what a business it was going to be. All kinds of things had been put away in drawers and cupboards, and on shelves in my workroom with the idea, I suppose, that they might come in useful some day. I thought I'd kept on getting rid of all the really useless stuff by having a clear-out once a year. But when I came to do the job thoroughly I found that I hadn't. Here I came across a box crammed with such things as ancient pre-set condensers; there a bundle of ante-diluvian flexible resistors; here a broken-down transformer put aside for repairs, but never repaired; there a drawer-full of decrepit four-pin valve holders. They have all gone now, I am glad to say. I found recipients for such of them as could by any stretch of the imagination be of any conceivable use; the rest have gone into the dustbin. I confess, though, that I am already beginning to fear that I have disposed of all kinds of things for which I shall soon be yearning. Only last night I was seized with the idea of connecting a pair of 2,000-ohm phones to the extension loud-speaker terminals and remembered with a pang that I had parted with an output transformer (unused for about ten years) which would have been just the thing for the job. . .



**TIME TUNER. The device on the left is intended for attachment to any receiver with push-button tuning. It provides for the pre-selection of any one of ten stations at any time within a 24-hour range. The time tuner then switches the receiver on or off at the required times, automatically selecting the pre-determined wavelength for each period. It is stated that this American tuner does not interfere with normal operation of the receiver.**

### "TIME-BASE CIRCUIT"

THE simplified expression in the letter published under the above heading in the September 22nd issue should read:—

$$Ia = \frac{Va}{Ra + R(1+\mu)}$$

# Television Programmes

**An hour's special film transmission intended for demonstration purposes will be given from 11 a.m. to 12 noon each week-day.**

| Vision | Sound |
|---|---|
| 45 Mc/s | 41.5 Mc/s |

THURSDAY, OCTOBER 6th.

**3,** George Robey in Cabaret. **3.30,** British Movietonews. **3.40,** 179th edition of Picture Page.

**9,** Cabaret, with Arthur Askey and Richard Murdoch. **9.35,** Gaumont-British News. **9.45,** 180th edition of Picture Page. **10.15,** News.

FRIDAY, OCTOBER 7th.

**3-4.30,** Feature Film: Françoise Rosay in "La Kermesse Héroique."

**9,** "Now for Fun," Cabaret from Grosvenor House. **9.30,** British Movietonews. **9.40,** Bridge Demonstration, with commentary by Hubert Phillips. **9.55,** Cartoon Film. **10,** Music Makers. **10.10,** News.

SATURDAY, OCTOBER 8th.

**2.25-5.5,** Motor Racing. O.B. from the Crystal Palace. The transmission includes the race between Bira and Dobson.

**9,** Gaumont-British News. **9.10,** "London Wall," a comedy by John van Druten. Cast includes Victoria Hopper and John Turnbull. **10.25,** News.

SUNDAY, OCTOBER 9th.

**8.50,** News. **9.5,** Pepler Masque. **9.15,** "Mountain Waters of Natal"—film. **9.35-10.55,** "Trelawney of the Wells," a play by Arthur W. Pinero.

MONDAY, OCTOBER 10th.

**3,** Cabaret. **3.30,** British Movietonews. **3.40,** David Seth Smith presents Friends from the Zoo. **3.55,** Cartoon Film.

**9,** Yvette Gilbert, French Diseuse. **9.10,** Friends from the Zoo. **9.25,** Gaumont-British News. **9.35,** Cartoon Film. **9.40,** "A Farewell Supper," by Arthur Schnitzler. **10,** News.

TUESDAY, OCTOBER 11th.

**3,** Intimate Cabaret. **3.10,** Film. **3.30,** "Farewell Supper" (as on Monday at 9.40 p.m.). **3.50,** Gaumont-British News.

**9,** News Map II—China. **9.15,** "La Kermesse Héroique" (as on Friday at 3 p.m.). **10.45,** News.

WEDNESDAY, OCTOBER 12th.

**3-4.15,** "London Wall" (as on Saturday at 9.10 p.m.).

**9,** Speaking Personally. **9.10,** Agnes de Mille. **9.30,** "6.30 Collection"—Film. **9.45,** Gaumont-British News. **9.55,** "Storm over Wicklow," a comedy by Mary Manning. **10.30,** News.

# Modern Broadcast

*THE variety and complexity of modern broadcast receiver specifications make the choice of a suitable set a difficult matter for the beginner. This article shows where to look for the essentials of efficiency in simple sets, and discusses the relative importance of additional features which make for refinement of performance.*

THE receiver which gives the best all-round performance in the present congested state of the ether is undoubtedly the superheterodyne. It combines range with selectivity at low cost by the simple expedient of changing the different frequencies of signals picked up by the aerial to a predetermined fixed frequency at which they can be more efficiently amplified and filtered.

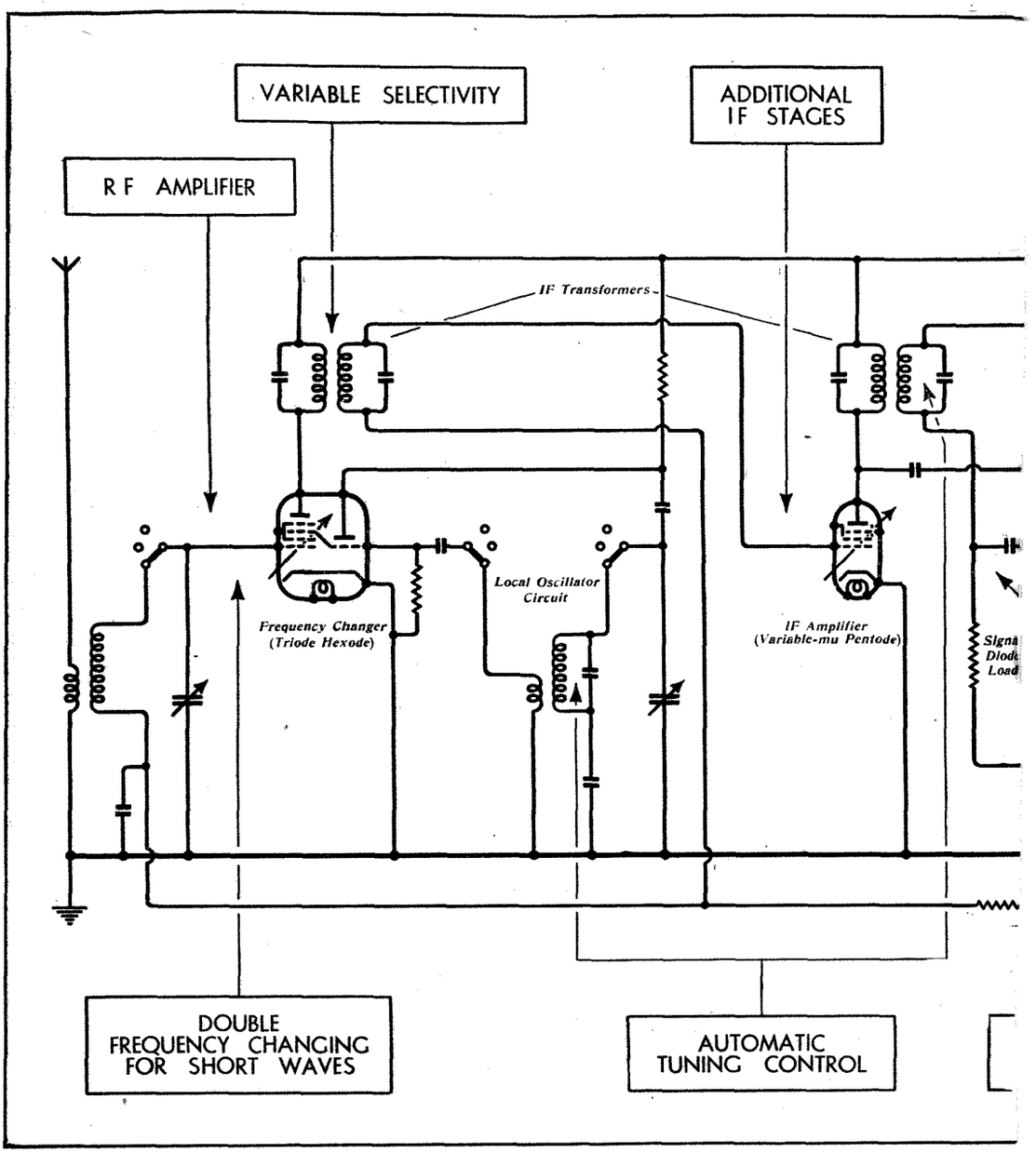
The transformation is effected by adding to the incoming signal a locally generated oscillation which follows the frequency to which the aerial is tuned at a fixed interval usually in the region of 465 kilocycles. The result is a heterodyne beat note of 465 kc/s which is above audibility and from which the full description of the "supersonic heterodyne" receiver was originally derived.

In the simplest superhets the dual functions of generating the local oscillation and mixing it with the incoming signal are combined in the first stage of the receiver. A constant frequency difference between oscillator and aerial circuits is maintained by ganging together the two tuning condensers, and either shaping the vanes differently or introducing an arrangement of trimming and padding condensers. It does not very much matter what type of frequency changer is used—heptode, octode, triode-hexode or separate valves for oscillator and mixer. The choice is often a matter of internal politics in the works designs department, but there is generally a preference for the triode-hexode on account of its freedom from pulling between the oscillator and signal-frequency circuits and its ability to function better on wavelengths below, say, 16 metres.

### The Heart of the Set

The next stage in our simple receiver will be the intermediate amplifier upon which the range and selectivity of the set chiefly depends. It will be a single valve preceded and followed by transformers with both primary and secondary windings tuned to the beat or intermediate frequency of 465 kc/s. Since this stage functions at only one frequency its amplification can be made much higher and the selectivity of its four tuned circuits will be uniformly sharper than would be the case if it were called upon to cover the wide range of frequencies represented by the short, medium and long wave broadcast bands. The usual valve is a variable-mu pentode so designed that the amplification ("mu") may be controlled by applying a negative bias to its grid without producing distortion.

This bias which is the basis of automatic volume control is derived as a by-product of rectification in the third stage of the set and is proportional to the strength of the incoming carrier wave. To obtain better control the AVC bias is also applied to the mixing section of the frequency-changer which is also designed on the variable-mu principle. The rectifier or second detector, as it is sometimes called, is invariably a diode—the simplest form of valve. Its primary function is to "demodulate" the output from the IF amplifier which still carries the speech of music modulation present in the signal originally picked up on the aerial. The result of rectification is a complex current developed in a load resistance in series with the diode. There is a continuous current component, the resulting voltage from which is filtered through resistances and capacities and used for AVC bias, and a fluctuating audio-frequency component which is passed through a volume control potentiometer to the amplifying stages immediately preceding the loud speaker.




**Skeleton circuit diagram of the modern superheterodyne shorn of such necessary complications as decoupling,**

# Receivers

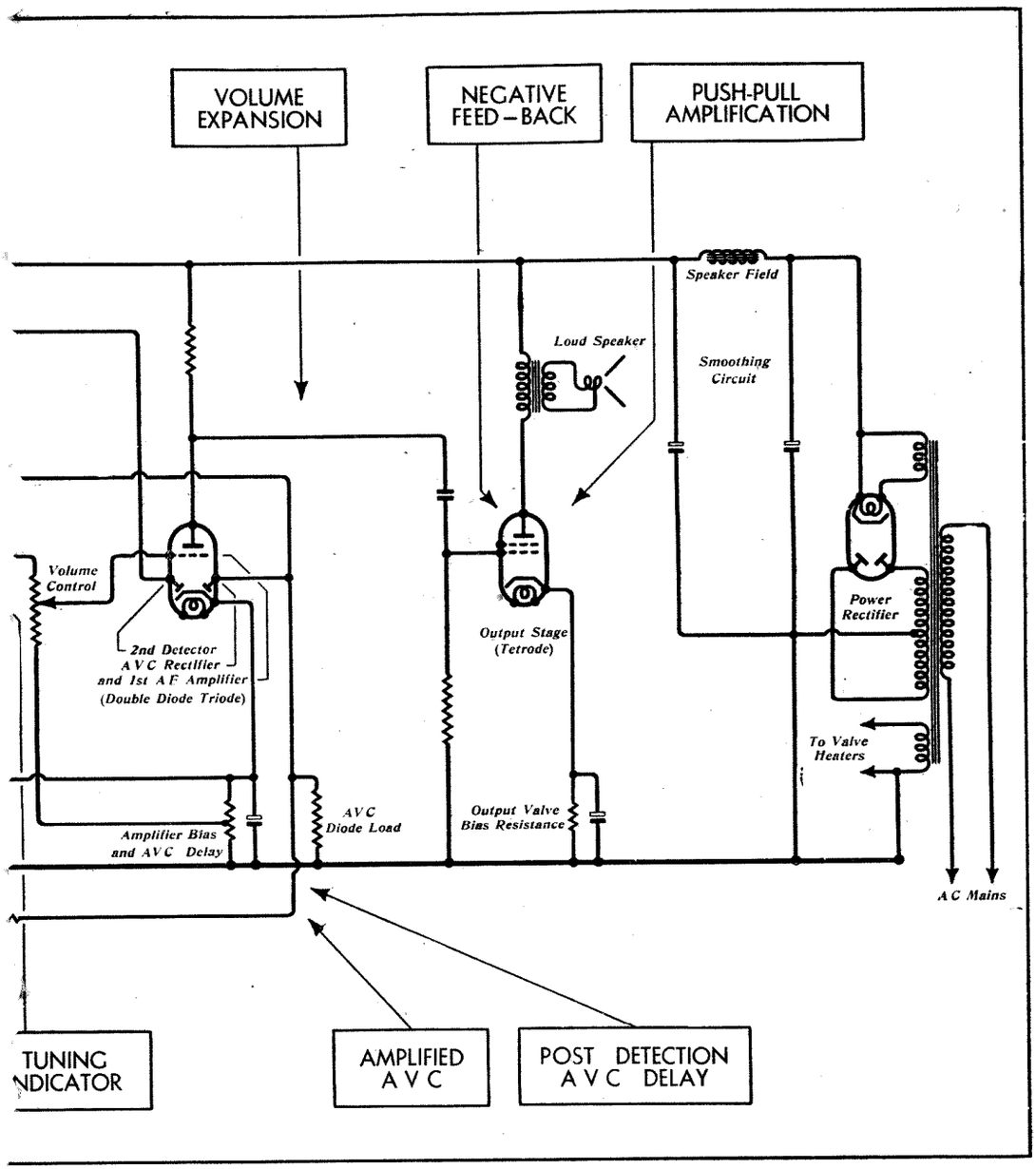
## BASIC DESIGN FOR EFFICIENCY AND FEATURES WHICH MAKE FOR REFINEMENT OF PERFORMANCE

One of these stages, usually a triode, is included in the same valve as the rectifiers. In the simplest three-valve superheterodynes a special high magnification pentode output valve is combined with the diodes, but most designers prefer to use a triode here as a first stage of AF amplification with resistance coupling to a separate pentode or tetrode output valve.

To give designers the widest possible scope two diodes are included in the second detector stage, and these may be used in a variety of ways. Sometimes they are joined together as a single diode which has a low impedance and can be easily adapted to avoid loss of high notes in the associated circuits. More often one diode is used for signal rectification and the other for AVC. With this arrangement the AVC is derived from the primary of the IF transformer—i.e., from the third instead of the fourth tuned circuit. Since the selectivity of the third stage is broader than the fourth, the signal comes under the influence of AVC before it reaches exact tune and "side band shriek" is avoided.

To maintain the sensitivity of the receiver at its maximum over a range of weak signal strengths, AVC action is delayed until a predetermined threshold is reached by the simple expedient of including a fixed bias resistance in series with the cathode of the second detector, which prevents the AVC diode from rectifying until the desired input is reached.

Of the power supply unit there is not much to be said. In AC sets the rectifier is usually a double diode valve giving full-wave rectification, and in AC/DC sets the two electrodes are connected in parallel for half-wave rectification on AC mains and to give a lower internal resistance with less loss of volts on DC supplies. The field winding of the moving coil loud speaker is generally included in the smoothing circuit of the main HT line.




RF filters, etc. Points at which refinements may be added are indicated by arrows and "boxed" lettering.

### Possible Additions

These are the bare bones of the modern superheterodyne circuit. They constitute the framework of even the cheapest sets, costing £10 or less, and are sufficient to ensure a wide choice of stations, reasonably free from interference and fading, at a standard of quality over which few will quarrel. On this foundation it is possible to build almost without limit either in technical complexity or cost, and the difficulty which confronts the purchaser who is willing to pay something extra for additional refinements is to decide which of the many possible "frills" will fit in best with his interpretation of efficiency or refinement of service.

Let us run through the basic circuit, point by point, and see where additions or improvements are possible. First, we can add a radio-frequency stage before the frequency changer to amplify the incoming signal. This may appear a retrograde step in the light of what we have previously said of the advantages of the superheterodyne principle. In practice it makes a very real difference to the performance of the receiver, particularly in reducing background noise in relation to weak signals. Since it is tuned to radio frequencies it discriminates against the low-frequency impulses associated with atmospherics and other sources of background noise. The additional tuned circuit used in the coupling between RF amplifier and frequency changer also helps to reduce image or second-channel interference, which is caused by residual pick-up when the tuning control and its associated oscillator circuit is on the "wrong side" of an unwanted station.

Modern frequency-changing valves do their work well, and one cannot very well buy improved performance in this stage. Two IF stages, on the other hand, are well worth having. The extra range which they confer is not always usable, but the re-

quired performance is maintained longer as the valves deteriorate with time. A much more effective AVC system can be designed with two than with one IF stage under control, and the selectivity of the additional tuned circuits is valuable to those interested in distant reception. In fact, the selectivity may be too great for local station work and quality may suffer. Two IF stages should therefore be accompanied by variable selectivity, and even with one stage is not to be sneezed at, since in most sets the designers are forced to sacrifice some quality to attain the degree of selectivity demanded by modern conditions. Variable selectivity is usually achieved by varying the coupling in the first IF transformer either by movable coils or by switching in a third winding to widen the response. Unless variable selectivity is well done, however, it may introduce more distortion by lack of symmetry in the resonance curve than that which is caused by the original narrowness of reponse.

### Automatic Tuning

Another refinement essentially associated with the IF amplifier is automatic tuning or frequency control. A pair of diodes in push-pull are fed from a special output transformer connected to the final IF stage. If the signal is in tune an equal and opposite current is produced at each diode. Slight mistuning causes an increase in one diode relative to the other, and the voltage so produced can be used to alter the tuning of the oscillator circuit through a valve arranged to behave as a variable reactance. The circuit operates so that the tendency is always to bring the diode currents back into balance and the station into exact tune. It is a particularly valuable adjunct in receivers with press-button tuning, or on the short-wave ranges where the tuning may drift as the result of changes of temperature in the cabinet.

The system of delayed AVC described earlier in this article is subject to a trace of distortion due to changes in the damping on the preceding tuned circuit and when high quality of reproduction is sought after a more complicated detector arrangement is generally adopted. One of the best methods of removing any suspicion of distortion from this cause is to use amplified AVC with a separate IF stage, the delay being applied to the separate diode following this buffer valve. Other systems, which do not, however, confer additional amplification and range of control, involve the application of the delay voltage through a separate diode which ceases to conduct and permits normal AVC action when a sufficiently strong signal is received.

In sets without automatic frequency control where good quality of reproduction is dependent on the accuracy of setting of the controls, a tuning indicator is a most useful accessory. The type most widely used consists of a miniature cathode-ray tube incorporating its own triode amplifier. The control voltage is taken from the signal diode and the resonance is indicated by narrowing of the shadow sector on the circular fluorescent screen.

There are ample opportunities for the wise expenditure of money on the output stage. Sets with negative feed-back are noticeably clearer in quality near the limit of their power-handling capacity than those with "straight" connections for the single pentode or tetrode output valve. The procedure is to return a part of the output voltage in opposition to the input and the process is the reverse of that in the familiar reaction or regenerative circuit. The first result is a reduction of amplification, but this disadvantage can be easily allowed for in the earlier stages of the set. The advantages are, first, a cancellation of harmonics generated in the last stage and, secondly, if properly arranged, a reduction in the output impedance of the valve which can be usefully employed in damping any tendency to resonance in the loud speaker.

Negative feed-back circuits also lend themselves to a simple form of "volume expansion" circuit in which the variation in resistance of a small pilot lamp included in the return lead reduces the feed-back at high volume levels and so increases the magnification. The contraction of volume range, necessarily introduced at the transmitter, is thus to some extent restored. Obviously we cannot retain the full advantages of negative feed-back with this scheme and a better though more expensive method is to use a separate volume expansion circuit involving two or perhaps three extra valves between the detector and output stages.

### Push-pull Output

Even better from the quality point of view than negative feed-back is the use of a push-pull output stage. The cancellation of harmonic distortion is achieved without loss of amplitude by this method, and with two valves the power-handling capacity is at least doubled. Best results are obtained with a symmetrically balanced resistance-coupled or transformer input circuit, and, generally speaking, with triode output valves.

Tone control should theoretically be unnecessary in a well-designed receiver working under ideal conditions. In practice there are considerable differences in the quality of transmitting stations and the characteristics of listening rooms. These can often be modified to meet individual opinions as to what constitutes an agreeable sound. A tone control is also useful in covering up the effect on quality of the difference in selectivity between the long and medium wave ranges in many low-priced sets.

Refinements directed to the simplification of tuning such as alphabetical scales and press-button tuning are primarily of a mechanical nature, though it is worth remembering that press-button tuning has made us a gift of really effective interstation noise suppression which hitherto had been achieved only by adding further possible sources of distortion to an already complicated second detector stage.

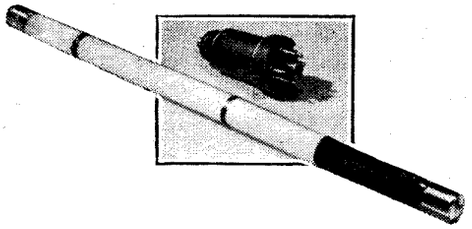
### Double Frequency Changing

One important method of overcoming critical tuning on short waves is essentially electrical in character and employs the double superheterodyne principle. The main receiver is switched to the medium-wave band and a separate frequency-changer converts the short-wave signals to intermediate frequencies lying in the medium-wave band. Instead of varying the frequency of the local oscillator the intermediate frequency is changed; on short waves the input circuits are sufficiently flatly tuned to permit this reversal of the usual procedure. By this method short-wave signals are tuned in on the main tuning condenser and a single broadcast band such as the 16-metre or 19-metre is expanded to occupy the whole scale, hence the system is often described as "electrical band spreading."

With unlimited means at our disposal we would like to see all these refinements included in the set of our choice; but if we cannot have them all, the points at which we start to make additions to the basic circuit will depend on whether we are primarily interested in the programme from the local station or in long-distance and short-wave reception. The former school will look first to the output stage and demand a set which includes push-pull valves, a large single output valve or at least negative feed-back. The latter will insist on a stage of radio-frequency amplification before the frequency-changer to increase range and improve signal-to-noise ratio. The quality enthusiast will turn first to the detector stage and demand with it a distortionless AVC system. In the IF amplifier, variable selectivity and a second stage of amplification should help to reconcile the conflicting interests of both parties.

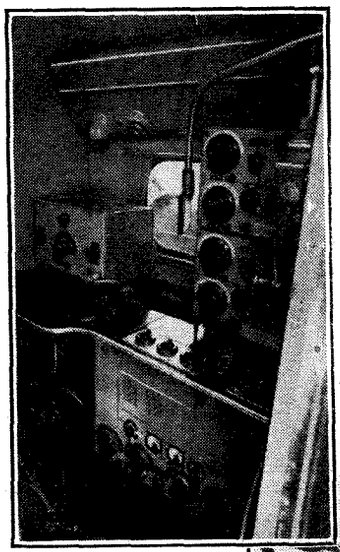
Other features may be added to taste, but it should be borne in mind that "frills" which do not contribute directly to the type of performance in which we are interested serve only to increase the chances of breakdown. On the score of reliability, however, we must inevitably be guided by the reputation of the maker concerned.

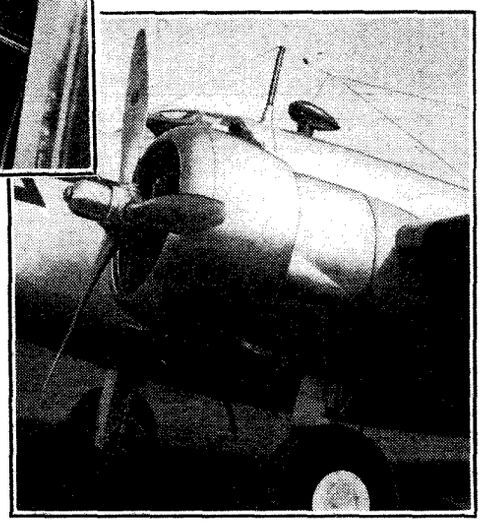
MODULATION INDICATOR.



**This gas-filled tube, coated internally with fluorescent material, has been produced in America as a simple modulation indicator for amateur transmitters. The rise and fall of the glow in the tube indicates relative modulation, a band round the tube corresponding to the maximum percentage modulation allowed by the Federal authorities.**

# NEWS OF THE WEEK





—The DF aerial can be seen on the right below the fixed aerial. This machine has a comprehensive Marconi wireless installation, shown above, which consists of a short- and medium-wave transmitter and short- and medium-wave receivers. A visual DF indicator is also fitted.

### AN HISTORIC 'PLANE

The first British machine to be fitted with the new Marconi streamlined direction-finding aerial is the British Airways' Lockheed Electra, which carried the Prime Minister on his first visit to Herr Hitler on September 22nd.—

## BROADCASTING IN A NATIONAL EMERGENCY

### A Regular News Service

HAD the war clouds which overshadowed Europe throughout last week not dispersed, British broadcasting would have been revolutionised. Arrangements had been made whereby everything would have been concentrated on the provision of frequent news bulletins, probably interspersed with light programmes mainly of gramophone records, throughout every twenty-four hours.

The majority of the staff retained at Broadcasting House would have been concerned with the preparation of the news bulletins and work of an emergency character. There would, for instance, be the handling of notices affecting the social and economic life of the public, including, presumably, information regarding the purchase of food. During the Great War a national food journal was published weekly by the Ministry of Food. The information then given might now very well be broadcast.

In short, everything had been arranged to ensure a regular broadcasting service.

The television service would, it is stated, have been suspended in the case of a national emergency. We understand, however, that no decision had been taken as to whether the ultra-short wave transmitters—sound and vision—would have been used for other purposes.

## NEWS BULLETINS

### The B.B.C.'s Gigantic Task

LISTENERS throughout the country must be loud in their praise of the B.B.C. for its restrained and balanced news service during the dark days of last week. It was indeed a colossal task for the B.B.C. News Department to correlate all the incoming news and to present it in a form which was calculated to give the truest picture of the events both at home and abroad. With the News Department must be coupled the stalwart announcers who so unaffectedly and yet so confidently read the long news bulletins.

The Programme Planning Department, too, had an extremely difficult task in rearranging the scheduled programmes to accommodate the extra long news bulletins and additional items.

### JAMMING IN WAR-TIME

THE possibility of the jamming of British broadcasts in time of war has been overestimated in certain quarters. Within the service area of B.B.C. stations it is extremely unlikely that a foreign transmitter could blot out signals. It must be remembered that heterodyning which may ruin the artistic effectiveness of a symphony concert may still be insufficient to render speech unintelligible.

## CZECHOSLOVAKIA

### Broadcasting Stations and the New Frontiers

THERE are no Czechoslovakian broadcasting stations in the areas which are being ceded to Germany, but the 5-kW. 249.2-metre Moravska-Ostrava station comes within one of the areas in which a plebiscite is to be held.

It is not yet known what will happen to the 100-kW. 269.5-metre Melnik German-speaking transmitter, which has so far been the only station which provides for a foreign language minority. The studios of this station are in Prague, but the transmitter itself is situated at Melnik, some twenty miles to the north of the city, and this will now come within five miles of the ceded territory.

## INDIAN BROADCASTING

### A.I.R. Revenue and Expenses

TO correct what is stated to be a widespread misconception that Indian broadcasting is not able to pay its way, *The Indian Listener* has published figures showing how the revenue and expenditure has grown since 1932. Revenue in excess of expenditure has gradually increased from Rs. 91,450 in 1932-3 to Rs. 793,120 in 1937-8.

Of the Indian Government's grant of four million rupees for broadcasting expansion, only Rs. 1,559,400 has been spent up to the end of the year 1937-8. The fact that three new stations have been built and eight transmitters installed with so small an expenditure is remarkable.

## MALAYAN BROADCASTING

### B.B.C. Help Wanted

THE suggestion that the B.B.C., through one of its representatives, should organise a broadcasting system in Malaya was made at a recent meeting of the Kuala Lumpur Amateur Radio Society.

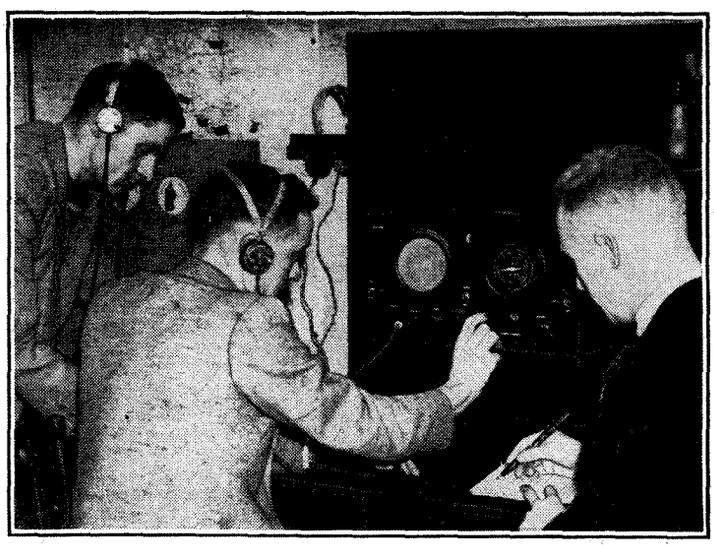
The service in Malaya, which has been carried out by this society for nearly nine years, will probably be suspended in November. It is now urged that a B.B.C. organiser should take over control of the entire system and that the Corporation might also supply recorded programmes.

Residents in Singapore have addressed a letter to the British Colonial Secretary, Mr. Malcolm MacDonald, appealing for "a measure of support from the Home Country which will enable us to obtain some sort of entertainment through the medium of the microphone.

"There can be no gainsaying the fact," continues the letter, "that Singapore and the whole of Malaya is shockingly served from a broadcasting point of view. The local station is so crippled financially that anything in the nature of worthy payment to intelligent artists is quite out of the question."

## MILAN RADIO EXHIBITION

ITALY'S tenth National Radio Exhibition, which closed on September 25th and included some ninety exhibitors, revealed that only twelve sets exhibited

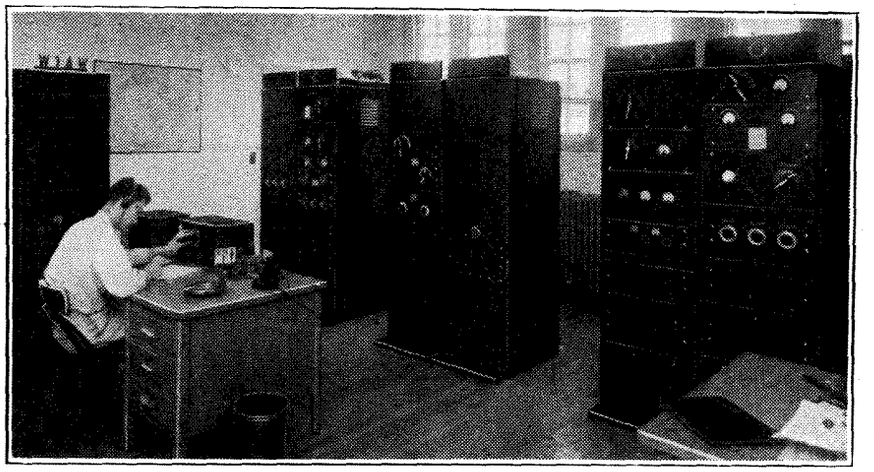


IN TRAINING. Some of the members of the Sheffield branch of the R.N.W.A.R. at the communications receiver with which, during training classes, they are in constant touch with the battle cruiser *Ramillies*, at sea.

**News of the Week—**

included automatic tuning devices. All of these had auto tuning for ten stations on the medium waveband, except in the case of the eighteen-valve all-wave set shown by the Phonola Company. This set covers eight wavebands on each of which eight stations are automatically tuned.

Nearly all the Italian AC sets are fitted with mains transformers with tappings for any supply voltage between 100 and 270. This fact, it is emphasised by our correspondent, should be noted by the British manufacturers if they wish to export sets to Italy.



THE TRANSMITTING ROOM of the Maxim Memorial Station, WIAW, contains five independent transmitters. The station which was recently inaugurated by the President of the American Radio Relay League, is dedicated as a tribute to the founder of organised amateur radio, and will serve to perpetuate his name in the world of amateur wireless.

## FROM ALL QUARTERS

### Relays and A.R.P

RADIO Relay Exchanges are not normally allowed to originate any material transmitted over their lines, but during the recent period of international tension the Home Office decided to authorise them to distribute emergency messages such as might be requested by the local Chief Constable or Air Raid Precautions Officer. It was further stipulated that such messages must not coincide with special B.B.C. announcements and that a copy of each message should be preserved.

### Obituary

IT is with regret that *The Wireless World* records the tragic death of Major-General Alan Dawnay on September 28th. He joined the staff of the B.B.C. in 1933 as Controller of Programmes, and became, in turn, Director of Information, Temporary Director of Empire Programmes, and finally Director of B.B.C. Publications. He returned to his old calling, the Army, in 1935, and at the time of his death was Director of Public Relations at the War Office.

### Microphone in Parliament

FOR the first time in Parliamentary history, microphone and amplifier equipment was used in the House of Commons last week when the Prime Minister made his speech and announced the momentous meeting of the Four Powers. Queen Mary, who was seated in the gallery, was able to hear every word clearly by means of the equipment, which was also used to relay the speech to the library of the House of Lords.

### Anti-interference Commission

THE French P.M.G. has appointed a special commission for the purpose of conducting investigations into the problem of electrical interference. The commission is constituted by representatives of national and private services.

### Radio in Italy

LATEST statistics from Italy show that during the year which ended on August 31st 180,000 sets were manufactured, which are valued at roughly £1,800,000. To this figure must be added the value of commercial, scientific and Service apparatus, which brings the total value of radio equipment to approximately £3,500,000.

### Olympia Radio Station

WIRELESS amateurs overseas have been invited to transmit messages to visitors at the Woman's Fair, which is to be held in Olympia next month. The International Short Wave Club has arranged to equip the Fair with a receiving station.

### Solving the Wavelength Problem

THE meeting of the International Broadcasting Union, planned for October 3rd, has been postponed provisionally for a month on account of the international situation. The deliberations will be mainy concerned with evolving a new European wavelength plan.

### Organ Frequency Test

REGINALD FOORT is to take listeners on a second conducted tour of the B.B.C. Theatre Organ on October 14th. The first tour, which was broadcast on August 11th, aroused widespread interest amongst *The Wireless World* readers, who were particularly interested in the run up the scale from 32 to 8,000 c/s. This "response test" will be repeated, though, as stated in our issue of September 22nd, it does not necessarily provide a conclusive test of a receiver's capabilities.

### Power Boost

As previously announced, the General Electric international short-wave station, W2XAD, at Schenectady, New York, is to raise its power of 18 kW to 100 kW. The reconstruction necessitated by this change is now well advanced, and the new transmitter will be put into service on November 1st.

### It Has Been Said

"BROADCASTING in these tense days is essentially linked up with National defence."—Mr. John Coatman, B.B.C. North Regional Director, at the opening of the Manchester Radio Exhibition.

"In my opinion, car radio is soothing to the nerves when covering a long journey. It encourages one to adopt a smooth, unhurried gait without distracting attention from the road and its problems. In this respect, then, surely it is a contribution to road safety?"—Mrs. Kay Petre in the *Daily Sketch*.

"Television is a reality in England. . . . The programme technique in America is amateurish alongside the technique developed abroad."—Radio Editor of the *New Brunswick Times*, New Jersey.

# Broadcast Programmes

## FEATURES OF THE WEEK

### THURSDAY, OCTOBER 6th.

Nat., 6.40, Godfrey Tearle and Margaret Rawlings in excerpts from "The Flashing Stream." 7.45, Mantovani and his Dance Orchestra. 8.30, Talk by Winston Churchill on "The Mediterranean." 9.25, "Autumn," from "The Seasons" by Haydn.

Reg., 7.30, Richard Strauss—A recital for 'cello and piano. 8.0, A discussion on Football Pools. 8.30, The Fol-de-Rols. 9.30, Duke Ellington and his Orchestra relayed from New York.

*Abroad.*

Berlin, 7.10, Verdi Gala Concert, celebrating the 125th anniversary of the composer's birth.

Hilversum II, 7.55, The Concertgebouw Orchestra conducted by Mengelberg, with Gieseking, pianoforte.

### FRIDAY, OCTOBER 7th.

Nat., 6.25, "The English Family Robinson" by Mabel and Denis Constanduros. 7.20, Ken Johnson and his West Indian Dance Orchestra. 8.0, "What Happened at 8.20?" 8.45, Mr. Gillie Potter. 9.25, "Advance in the Air,"—talk.

Reg., 7.30, "Ending It," from a story by Val Gielgud. 9.30, Variety from Aberdeen.

*Abroad.*

Prague, 7.40, "Wanda," opera (Dvorák).

Warsaw, 8.15, Symphony Concert, with Egon Petri, pianoforte.

### SATURDAY, OCTOBER 8th.

Nat., 5.0, Ambrose and his Orchestra. 7.30, In Town To-night. 8.0, Music-Hall, with Lily Morris and George Robey. 9.25, American Commentary. 9.40, "I Have Been Here Before," play by J. B. Priestley.

Reg., 6.0, First of a Series from America—"Musical Seesaw." 7.30, Elgar Recital by The Midland Singers. 9.40, Commentary on Table Tennis—England *v.* France.

*Abroad.*

Radio Eireann, 2.15, The McCormack Farewell Concert from Dublin.

Brussels, 8.0, "The Desert Song," operetta (Romberg).

### SUNDAY, OCTOBER 9th.

Nat., 11.20, "Down in the Canebreak," with Phyllis Scott, John Rorke and Mario de Pietro. 2.0, C. H. Middleton. 6.15, Noel Coward's "Cavalcade." 9.5, Songs of the British Isles.

Reg., 6.45, Spelling Bee—Employers *v.* Secretaries. 7.15, Reginald Foort. 9.5, First Sunday Orchestral Concert of the 9th Season.

*Abroad.*

Saarbrücken, 6.0, "The Flying Dutchman," opera (Wagner).

### MONDAY, OCTOBER 10th.

Nat., 7.0, Mr. and Mrs. Neemo. 8.10, Louis Levy presents "You Shall Have Music." 9.25, World Affairs.

Reg., 7.20, The Week on Wall Street, relayed from America. 7.50, Peter Sloan's Guitar Trio. 9.30, "General Release"—Songs from Films.

*Abroad.*

Leipzig, 8.0, Bruckner's Third Symphony played by the Leipzig Symphony Orchestra.

### TUESDAY, OCTOBER 11th.

Nat., 7.30, Class: An Enquiry into Social Distinction. 8.0, "Scrapbook for 1923." 9.25, Talk by Lord Elton—"It Occurs to Me." 9.40, Concert by the National Orchestra, relayed from Paris.

Reg., 8.30, The Under Twenty Club—Chairman, Howard Marshall. 9.0, Variety from Bristol. 9.35, After Dinner Cabaret.

*Abroad.*

Hamburg, 7.0, "Falstaff," opera (Verdi): State Opera House.

Paris PTT, 9.0, Franco-Belgian Soirée, in the presence of the King of the Belgians and the French President, at the Salle Pleyel.

### WEDNESDAY, OCTOBER 12th.

Nat., 7.15, Horner's Corners. 7.45, The World Goes By. 9.25, D'Erlanger's Requiem Mass.

Reg., 6.0, Edna Hatzfeld and Mark Strong at two pianos. 7.30, "England, South and East." 9.25, "The Son of the House," play.

*Abroad.*

Lille PTT, 8.30, Acts III and IV, "Boris Godunov," opera (Mussorgsky).

# Free Grid at the Manchester Show

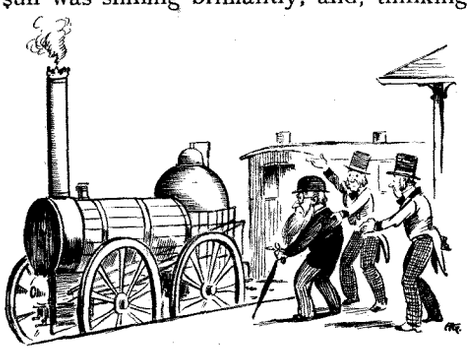
## AN EPIC JOURNEY

IN spite of the attempts made to prevent my gaining admission to the Manchester Show, I managed to circumvent the official ban by cultivating a crop of face fungus, as I stated in these notes on September 15th that I intended to do. The process of growing the necessary fungus was extremely inconvenient, as it held up a good deal of my constructional work, which I was obliged to suspend altogether after one or two unfortunate encounters between my newly grown beard and a hot soldering iron; indeed, had it not been for the good offices of the Editor of this journal I should have been in a sorry plight. He informed me confidentially that a certain well-known figure connected with the wireless industry in a literary capacity, who is rather famous for his magnificent hirsute adornments, owes his luxuriant growth solely to the fact that he exposes his face for ten minutes every morning to the radiations of an oscillator working on a wavelength of about 50 centimetres. My present beard bears ample testimony to the truth of this information.

I regret to say that right from the very start of my journey to Manchester I was dogged by misfortune, as, when I reached Euston, the officials, noticing my patriarchal beard, thought that I was one of the participants in the L.M.S. Centenary Exhibition which was being held there, and I was hastily hustled into a train of 1838 vintage which was just on the point of leaving. I had considerable difficulty in explaining matters to the officials on duty on the train, and when I had finally convinced them of their error I was unceremoniously bundled out on to the permanent way and left to wend my hazardous way back to the station.

### A Meteorological Phenomenon

When my train reached Manchester the sun was shining brilliantly, and, thinking



Hustled into a train of 1838 vintage.

that I had not yet arrived, I continued reading the copy of "East Lynne" which had been thrust into my hands when I was hustled into the 1838 train and which the officials had forgotten to retrieve when they bundled me out. The result of this was that my train was shunted into the sidings with me in it, and I had some difficulty in explaining matters to the railway police. They pointed out that they were not doubting that it was the presence of sunshine which had caused me to think that the train had not reached Manchester, as they had had several cases that morning of bewildered travellers being shunted into the sidings for the same reason. What roused their suspicions was my appearance and the fact that my explanation did not ring true, as, owing to an error in my engagement book, I had arrived a week before the Wireless Show opened. In the end, however, I was released owing to the good offices of a shunter, who recognised me, in spite of my beard, as a fellow enthusiast who had met him some years previously when buying components at the "Flat Iron," which, as my Northern readers will know, is one of the recognised gathering grounds of radio enthusiasts in search of bargains up North.

### The Exhibition

I managed to get into the City Hall without being detected, however, although, in spite of my newly grown beard, I rather fancy that my features were still recognisable. I certainly had a very narrow squeak, as my beard became entangled in the revolving turnstiles, and I was afraid that one of the many officials whose attention was attracted by my predicament would smell a rat. The really weak spot in my disguise which might have betrayed me was my voice, but, fortunately, I had spent the previous few days wisely in acquiring an absolutely unimpeachable Northern accent, and as soon as my beard was disentangled from the turnstiles I was unceremoniously bundled into the hall as though I were an actual dyed-in-the-cotton Mancunian ham.

The Show was undoubtedly good and did not suffer one whit from the fact that television was completely absent; in fact, it gained from it, as the music from the loud speakers was quite tolerable owing to the fact that the non-television firms were not endeavouring, as they were at Olympia, to drown out the sound part of the television programmes by sheer superharmonic distortion (*pace* "Cathode Ray").

In the matter of answering technical questions, the young men on the stands at Radiolympia have got a very great deal to learn from their hardy confrères up North, and as a typical example I will quote my experience at a certain stand, where one of the exhibits was a portable set about which I happened to know a good deal, as I have personally tested it. A sturdy son of toil was displaying great interest in it, and demanded to know what its weight was. He at once received the definite and unequivocal reply that it was 24 lb. instead of the vacillating and vague response which I feel sure he would have got down South.

My beard became entangled in the turnstiles.

I at once butted in, however, and pointed out that the young man on the stand was doing the set an injustice, as I had weighed it and found it to be only 23¼ lb. The young man, instead of accepting my correction in the spirit in which it was offered, immediately adopted a superior manner and stated that I had quite obviously weighed the set when the accumulator was partly run down, and, to my astonishment, the crowd round the stand sided with him, and I was admonished with Northern bluntness not to meddle with matters which didn't concern me and about which I was, in any case, obviously ignorant. In high dudgeon I removed myself and my beard to another part of the hall.

### Which Way Does the Current Flow?

I next went in search of the electric eel which had been on show at Radiolympia, as I had noticed a technical inaccuracy in the circuit diagram exhibited with it there, and I had not had the necessary time to point it out. To my chagrin I found that the eel was not on show, although I luckily found a representative of Exide's, the eel's owner, in the milk bar, and I at once pointed out to him that the direction of the current flow was wrongly marked in his firm's diagram, which showed it flowing round from the head (positive) to the tail (negative), which, if true, meant that current flowed from the anode of a valve through its innards to the cathode. He attempted to confuse the issue by pointing out that I had probably been led astray by observing bubbles rising from the eel's breathing apparatus and that this had led me to assume that the head was negative, on the principle of the old dodge of finding the polarity of the mains by sticking them in a glass of water and watching for the bubbles. Our argument grew so heated that we attracted the attention of other technicians in the bar, with the result that before we knew where we were we found that we had all been ejected into the street.

# Recent Inventions

***Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.***

## MICROPHONES

WHEN a microphone is used out of doors the action of the wind frequently produces a background of disturbing noise. In order to prevent this the ordinary dust-cap placed over the moving diaphragm is supplemented by a somewhat larger curved shield with perforations both in its rounded front surface and in a flange which separates it from the dust-cap.

The flow of wind through the front perforations and its escape through the holes in the side-flange produces, by the well-known Bernoulli principle, a region of low pressure in front of the diaphragm of the microphone, and so stabilises it against vibrations which would otherwise be produced by the action of the wind and which give rise to the objectionable noises in question.

*Marconi's Wireless Telegraph Co., Ltd. (assignees of W. D. Phelps). Convention date (U.S.A.), January 14th, 1937. No. 486655.*

○○○○

## SHORT-WAVE TUNING-SCALES

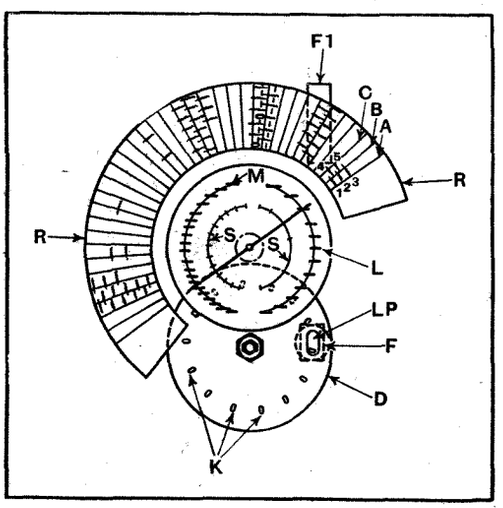
A SMALL movement of the tuning indicator on a short-wave receiver is sufficient to "straddle" several stations, and for this reason it is difficult to find enough room on the scale to mark all the available stations by name.

The arrangement shown in the Figure is designed to overcome this difficulty. The centre part of the drawing represents the usual type of scale in which the half-circle L shows the long, and the half-circle M the medium stations. The two inner half-circles S are usually left for the short-wave stations.

According to the invention, the latter are, in effect, duplicated on an outer ring marked R, which is marked with a series of radial lines A, B, C, etc. In other words, the limited space afforded by the inner circles S is replaced by a "scale" which begins at the lower or inner end of the radial line A, continues up to the top of that line, and then starts again at the lower end of the radial line B, continues along it to its top, starts again at the bottom of line C, and so on. The names of all the stations can then be printed, across the radial lines, as indicated at 1 - - 5.

This result is secured by the action of a lower disc D, which is geared to the main tuning-control and is provided with a circular series of slots K. The latter allow the light from a lamp LP to pass through so that it can be reflected, by inclined mirrors F, F1, on to the radial lines A, B, etc., as the slots K on the disc D cut across the scale markings on the two half-circular short-wave scales S.

*Marconi's Wireless Telegraph Co., Ltd.; N. M. Rust; and N. Levin. Application date December 11th, 1936. No. 486889.*




**Magnifying scale for multi-band receivers.**

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## ELECTRON MULTIPLIERS

RELATES to an electron discharge device of the kind in which primary electrons are used to produce an amplified stream of secondary electrons—usually by impact with an auxiliary electrode lying in the path of the primary stream.

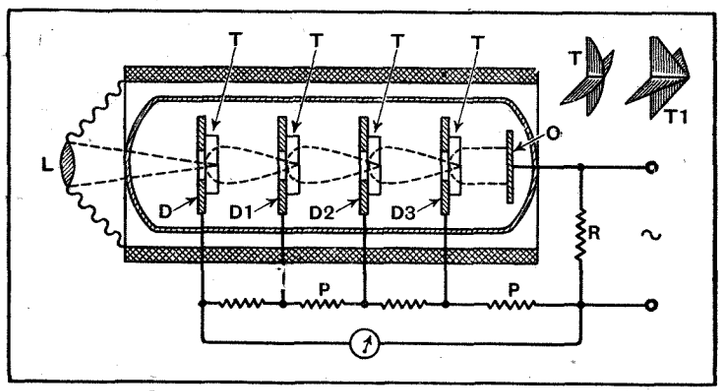
The inventors state that a more copious supply of secondary electrons is produced if the emitting electrode is arranged so that its surface lies substantially parallel with the path of the primary stream, instead of across it. Preferably two or more secondary-emitting surfaces are arranged parallel with the path of the primary stream, and are spaced apart from each other by a distance equal to their effective length as measured along the stream. Alternatively the secondary-emission surfaces may consist of a number of tubes concentric with the path of the primary or main stream.

*Baird Television, Ltd.; T. M. C. Lance; G. E. G. Graham. Application date, December 17th, 1936. No. 487328.*

○○○○

THE target electrodes in an electron multiplier are arranged more or less edgewise to the general direction of the electron stream, so as to obstruct the latter as little as possible.

In the Figure, light from a source (not shown) is focused through a lens L on to the central aperture of a disc electrode D. Mounted across the aperture is a target electrode of the form shown separately at T or T1. These electrodes offer a comparatively large surface for the impact of the primary electrons, so that a large number of secondary electrons are liberated. At the same time they do not appreciably impede the passage of the stream as a whole.




**Electron multiplier with target electrodes that do not appreciably impede the electron stream.**

The amplified stream is passed in succession through other disc electrodes D1 - - D3, which are fitted with similar strip-shaped targets, such as T and T1, and are biased with a progressively increasing voltage derived from a potentiometer P. The amplified stream is finally collected on an electrode O and passed to an external resistance R.

*V. Zeitline; A. Zeitline; and V. Kliatchko. Convention date (France) February 8th, 1936. No. 486795.*

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## LIGHT INTENSIFIERS

AN electron discharge tube designed to intensify the brightness of a television picture is formed of three limbs of equal length set at approximately equal angles to each other. A picture is projected through a lens on to a photo-electric screen arranged at the end of one of the limbs.

The resultant electron stream is focused by an electron-optical system on to a target electrode set at the end of one of the other limbs, the target being both coated and indirectly heated, so that it liberates a copious stream of secondary electrons.

The latter at first travel outwards against the stream of incident electrons, but since they are traversing the magnetic focusing or control field in the reverse direction they are soon deflected away from the primary stream. Finally they fall upon a luminescent screen set at the end of the third leg of the tube, where a more brilliant image of the original picture is produced owing to the amplification due to secondary emission.

*Radio-Akt. D. S. Loewe. Convention date (Germany), October 16th, 1935. No. 486750.*

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## DIRECTION-FINDING

THE radio-goniometer scale of a ship's direction-finder is usually fitted with two pointers, one of which indicates the signal minimum or "true bearing," whilst the other, set at 90 deg. to the first, shows the correct "sense" of the signal by removing the usual 180 deg. ambiguity.

According to the invention, the output from the radio-goniometer coils is fed to a cathode-ray tube indicator, and in order to expedite the operation of taking bearings, particularly on an aeroplane where rapidity is essential, a change-over "sensing" switch is inserted between one of the aerials and the field-coils of the radio-goniometer, so that the correct "sense" of the bearing is shown on the scale in one operation, without having to rotate the control knob through 90 deg. after the "minimum" position has been found. Under these circumstances the cathode-ray indicator-scale can be fitted with a "cursor," so as to allow the attention of the operator to be concentrated on a comparatively small section, which can be illuminated from behind.

*J. P. Jeffcock. Application date, November 14th, 1936. No. 487048.*

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*As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.*


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# *EDITORIAL COMMENT*

## The Post Office and Amateur Transmitters

### *Need for a Change of Attitude*

THE Wireless Telegraphy Act requires that the Postmaster-General should grant facilities for experiments in wireless telegraphy. These facilities were naturally suspended during the period of the War, but about 1920 an agitation from amateurs resulted in their restoration. When licences were again granted it was with the difference that a distinction was made between an experimental licence for receiving and a licence which gave authority to transmit as well. Whilst experimental receiving licences were issued freely, transmitting licences were only granted subject to a number of regulations and to the attainment of a certain standard of proficiency in transmitting and receiving in the morse code.

The Post Office attitude has apparently always been that before a licence to use a transmitter should be granted satisfactory evidence should be produced by the applicant that he has some serious experimental work in prospect which he desires to carry out.

### *A Matter of Form*

We know, and the officials at the Post Office know, that only in exceptional cases is it the real intention of an applicant for such a licence to start at once on serious research. The application is almost invariably made because the amateur wants to be able to transmit and receive by wireless and get into communication with others having similar interests. If serious experimental work is done it is almost always as a result of a desire to improve the performance of a station. Amateurs have seldom set out deliberately to investigate those technical subjects on which they have contributed the greatest knowledge. Their interest has first been in the hobby of running a transmitting station, and interests of a more serious nature have followed logically.

We do not have to turn the calendar back very far to be able to appreciate how important it is to the country that there should be available in times of emergency a large body of skilled wireless operators. We know that a skilled operator cannot be created at short notice. Not in a month, six months, or even a year can a high standard of proficiency be attained.

Surely the time has come when the Post Office should remove every possible obstacle and encourage ownership and operation of amateur transmitters as widely as possible. But by all means let those regulations stand which will serve to control the frequencies used and ensure competence on the part of the operator, as a guarantee that he will not cause interference with other users of the ether.

### *Concessions from the G.P.O.*

In order to increase the popularity of amateur transmitting as a hobby, applicants for licences should be freed from the obligation of providing evidence as to proposed experiments. We would like to see, too, the removal of some of the present ill-defined restrictions as to the nature of the communications in which the amateur may indulge. At present these restrictions debar the amateur from communicating anything beyond the discussion of the nature of his experiments or purely personal matters. We believe that, without any damage to the monopoly of the Post Office, concessions might be given, provided that it is clearly understood that no remuneration for transmitting messages must pass and that nothing in the nature of commercial intelligence should be put over.

The Post Office should concede that the desire to become a proficient wireless operator is sufficient justification for the granting of a transmitting licence. The present requirements, particularly those relating to proposed experiments, have come to be regarded so much as matters of form that few applicants pay tribute to more than the letter of the regulations.

# Receiving Aerials

By
F. R. W. STRAFFORD
(Research Dept., Belling and Lee, Ltd.)

## WHAT IS "EFFECTIVE HEIGHT"?

THE term to be defined in the present article is ill chosen, since "effective height" is a quantity which is determined not so much by the geometry of the aerial system, as by its proximity to other objects, the wavelength of the signal, and the polarisation of its wave front. Consider a simple vertical aerial of height $h$ (Fig. 1) the base of which is placed close to a perfectly conducting earth. If this aerial lies in the path of an electro-magnetic wave of field strength $E$ volts per metre, whose electric intensity is vertical (vertical polarisation), then from elementary textbook theory the EMF developed between the points $a$ and $b$ is equal to the product of $E$ and $h$.

*ALTHOUGH the influence of aerial effectiveness on signal noise ratio is now widely recognised, there are many misconceptions as to what constitutes a good aerial, particularly with regard to the important quality of "effective height."*

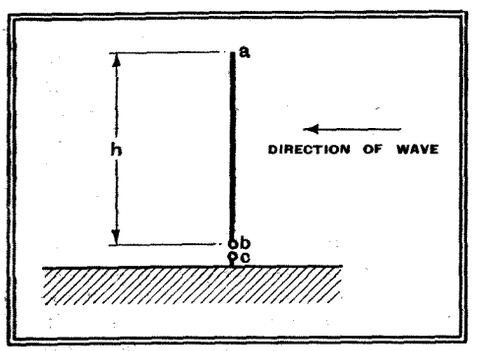



Fig. 1.—The simplest vertical aerial.

We do not, however, obtain the EMF which actuates a wireless receiver by connecting its input terminal between the points $a$ and $b$, for a very good reason which will be given later when we come to discuss frame aerials. Instead we connect the receiver input between the base of the aerial and earth, i.e., from $b$ to $c$.

A little consideration will indicate that the EMF developed between $b$ and $c$ must be less than that between $a$ and $b$.

We will redraw Fig. 1 (see Fig. 2*a*) by including the capacity which must exist between the aerial and earth, and for the purpose of our simple analysis will assume that it is lumped and not distributed to earth. In these circumstances it is not difficult to see that $C2 = C1$, so that we may construct a little equivalent circuit (Fig. 2(b)) from which it is at once obvious that if $C1 = C2$ then $V = \frac{Eh}{2}$ which is half the voltage between the tips of the aerial.

Hence the effective height of a vertical wire of height $h$ from the ground is equal to half its physical height in this particular case.

Naturally when we consider the distributed capacity it is obvious that the capacities of those parts near the top are less than those near the ground. Hence the effective height in practice will be slightly less than $\frac{h}{2}$.

In all the foregoing it must be assumed that the height of the aerial is small compared with the wavelength of the electro-magnetic field in which it is placed. For example, on a wavelength of 1,500 metres we may consider $h$ up to at least 100 metres, or roughly 300ft.

### On Tall Buildings

Now let us take an aerial whose actual physical length is 10 metres, and place it on top of a building 100 metres high (see Fig. 3, not to scale). The point $c$ will be connected to earth, perhaps not deliberately by a direct path but at any rate by a tortuous path through, say, the water-pipe system.

Now, the voltage induced in this system by a wave of field strength $E$ volts per metre will be $E \times$ (110 metres). In other words, it must not be forgotten that the earth lead is part of the aerial system if it is in the signal field.

It should be fairly obvious in this case that the voltage across $b$ and $c$ is likely to be much greater than if the portion $a$-$b$ had been at ground level, since it would only have $E \times 10$ volts developed in it by the signal. Hence the effective height of the skyscraper aerial is likely to be greater than its actual height above the roof.

It is very important, therefore, to realise that an aerial system consists not only of the elevated wires connected to the aerial terminal of the wireless receiver but to the combined effect of the wires and the earthing connection to the receiver.

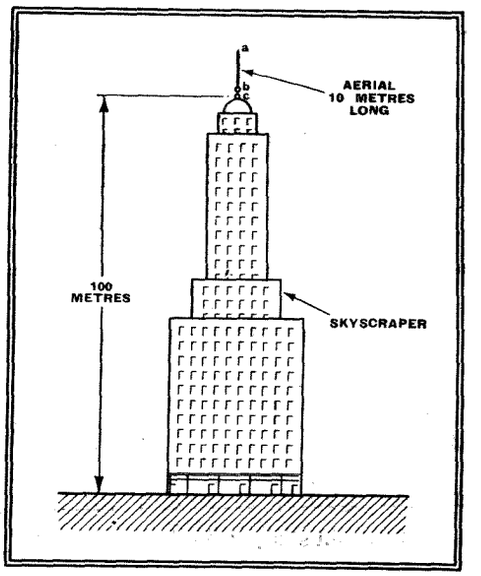



Fig. 3.—An aerial erected on top of a skyscraper is likely to have a greater effective height than if its supporting mast were set up at ground level.

This raises an interesting point. Consider again an elementary aerial (Fig. 4) but bend it into snakelike form. Provided that its end is at a height $h$ from the ground equal to the height of the original vertical aerial of Fig. 1, the induced EMF in its length is the same as that generated in the vertical aerial.

This is not difficult to understand because there is no EMF generated in any portions of the tortuous aerial which are perpendicular to the plane of the electric field. For every little element of length which turns upwards the action of the induced EMF counteracts that of every little element turned downwards.

In the foregoing it has been shown that the effective height of an aerial under a prescribed set of conditions is equal to half the height of its top above earth, but this is on the assumption that the aerial has been erected over a highly conducting earth, and that no other conducting obstacles have been placed in the path of the wave.

Let us imagine a large metal structure

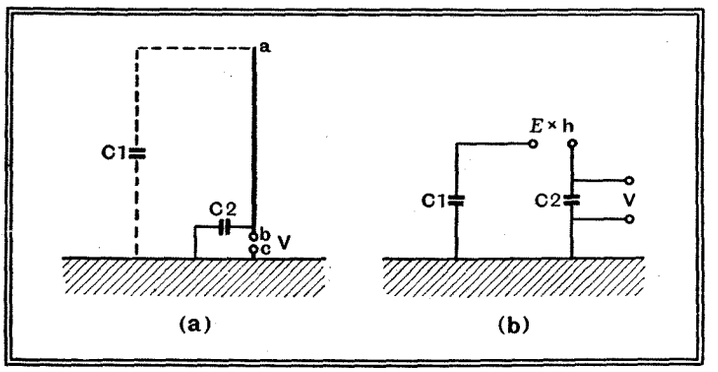



Fig. 2.—Diagram (*a*) shows the aerial of Fig. 1 with capacities added; diagram (*b*) represents the equivalent circuit.

**Receiving Aerials—**

such as a gasometer close to a simple vertical aerial of height $h$. In the absence of the structure the signal voltage available between its base and ground will be equal to $\frac{Eh}{2}$. Hence we say that the effective height of the aerial is $\frac{h}{2}$. In the presence of the structure we will find that the available voltage may be greater or less, probably less, and from our simple formula we may ascribe it to a reduction of either $h$ or $E$. Surely it is more sensible to say that $E$ has been modified, since this is what actually happens.

In the presence of the gas container the field acting upon our simple vertical aerial is composed of (1) the original wave, and (2) the effect of the field produced by the gas container, for the wave acts upon this and drives the electrons of its metalwork to and fro, thereby constituting an alternating current. This current obviously produces a field (by no means a pure electro-magnetic wave) and this field tends to oppose the effect of the true wave in the vicinity of the vertical aerial. The modified EMF is thus a function of the nett intensity *and direction* of the resulting field acting upon the aerial, and this change is specified by stating that the

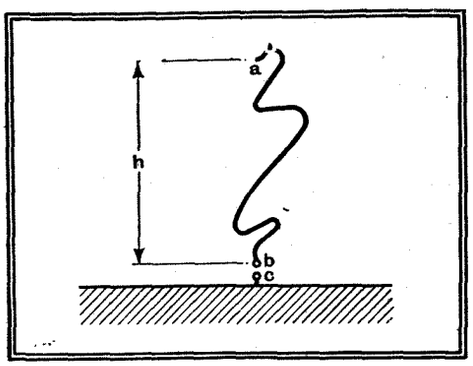



**Fig. 4.—Nothing is gained in effectiveness by using anything but a straight length of wire.**

effective height of the aerial has been changed.

Thus, if the voltage V developed between the base and earth of a short vertical aerial is given by $\frac{Eh}{2}$ and V1 is the voltage actually developed under certain conditions, we say that the effective height of the aerial under these conditions is obviously $\frac{hV1}{2V}$, which may be greater or less than $\frac{h}{2}$ according as to whether V1 is large or small compared with V.

The reason that the effective height may be greater than $\frac{h}{2}$ is merely because we assume that $\frac{h}{2}$ is the figure when the electro-magnetic field is polarised in a plane parallel to the wire. In practice it may depart from this idealised state, and the presence of neighbouring conducting structures producing secondary fields may result in a nett electric intensity in the vertical plane greater than that which would exist in their absence. Usually the reverse is the case and smaller values of effective heights are recorded in practice when aerials are erected in the vicinity of conductive neighbouring structures.

An aerial erected indoors is an example of this, and sometimes the reduction of effective height is very severe due to the house wiring, metal gutterings, metal window frames and water and gas pipes. In large blocks of flats where there is a great deal of girder work enormous reductions of greater than 50: 1 have been recorded.

## Simplifying the Issue

In all the foregoing the exact formula which includes the effect of the direction of polarisation of the wave and its frequency has been omitted because it would confuse the average reader. Perhaps a great deal of the foregoing explanation may lack some of the rigour expected by the mathematical physicist, but the author must have mercy on the reader.

If the electric intensity of the electro-magnetic wave is acting in a vertical direction then it is obvious that the addition of a horizontal "roof" to the simple vertical wire we have been considering will not increase the available electromotive force generated in the system. By its capacity to earth, however, it does increase the amount of current which can flow round the system and through the input impedance of a receiver connected between the base of the vertical portion of the aerial and ground; hence the effective input voltage to the receiver itself increases, and the effective height may thus be considered to have increased. It is quite clear, though, that the increase can never be very great, and in theory the limit tends to something like 1.6 times the voltage available without the addition of the roof.

If, therefore, the addition of a horizontal roof to any vertical aerial increases the available signal by more than the figure, it is quite obvious that the electro-magnetic wave in the vicinity of the aerial system is not vertically polarised, and that some additional electromotive force has been developed in the horizontal portion of the aerial.

This article would not be complete without reference to frame (loop) aerials, and before dealing briefly with them let us reconsider Fig. 1. It was stated in a previous paragraph that the addition of a horizontal roof to the aerial increased its effective height by increasing the available voltage between its base and ground. This increase, which is due to capacity only (remember the roof makes no contribution to the EMF when the wave is vertically polarised), might lead the reader to believe that a fixed condenser connected between the top of the vertical aerial and ground will have precisely the same effect as a roof having a capacity to earth of the same order. It does look like that at first, but let us give the matter a little thought.

Fig. 5 shows our original vertical aerial with the top now connected through a capacity to earth. The instantaneous EMF developed in (1) the vertical aerial, and (2) the connecting wire, will be of the same (or near enough) phase, hence the potential difference between $b$ and $c$ will be zero (or nearly so). The only factor which saves the potential from becoming zero is the finite separation between the two wires, and it is this fact which underlies the whole theory of the operation of the frame aerial.

If in Fig. 5 the capacity is made infinitely large, in other words, is short-circuited by a piece of wire, it is quite obvious that we have formed a simple frame aerial consisting of one turn of wire. If these two wires are located in such a manner that they are in the plane of the direction of the wave, that is, they are substantially as shown in Fig. 5, it has been earlier pointed out that no voltage would exist between the points $b$ and $c$. It will be noticed that these earlier statements were qualified by the words, "or nearly so," because it must be remembered that the wave has a certain finite velocity and its instantaneous amplitude in the vicinity of the first wire is not quite the same as the value in the vicinity of the second wire. In other words, there is a phase difference existing between the occurrence in the first wire and that in the second wire, and since the EMF produced in each wire must be added vectorially in order to obtain the resultant it will be seen that a slight difference must exist, and this slight difference gives a difference of potential between the points $b$ and $c$. Furthermore, it should be clear that if the wires are separated by a greater distance it will be obvious that this phase displacement will increase, and up to a certain limit the potential difference between $b$ and $c$ will increase; in fact, the effective EMF between the points $b$ and $c$ is a function of the area enclosed by the loop, no matter what its shape may

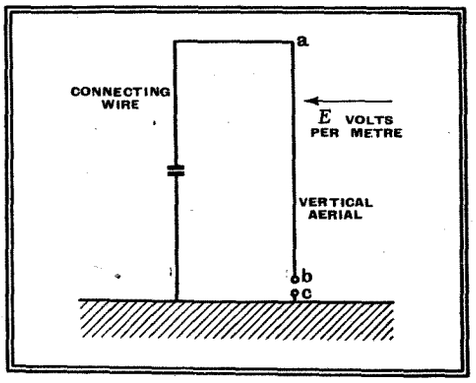



**Fig. 5.—A condenser connected between the top of a vertical aerial and earth.**

be. The formula for the voltage developed across the terminals of a frame aerial consisting of N turns of area A at wavelength $\lambda$ is $\frac{2\pi ANE}{\lambda}$, where $E$ is field strength as before. The voltage for a vertical open aerial of height $h$ between its base and earth is equal to $\frac{Eh}{2}$. Hence, for equal voltages between the terminals

**Receiving Aerials—**

of the two systems the equivalent height of a frame aerial may be obtained by equating these two equations one to the other and solving for the value of *he* (effective height). This gives the value *he* as $\frac{4\pi AN}{\lambda}$. Thus, the equivalent effective height of a frame aerial relative to an open vertical aerial of height *h* turns out to be a function of the wavelength, and becomes steadily smaller as the wavelength increases.

In actual practice it is customary to tune the frame aerial by means of a variable condenser, and thus resonate it to the desired wavelength. In this case we must multiply the open circuit voltage obtained between the ends of the frame aerial by its magnification factor, since it obviously contains inductance and resistance.

Now the effective Q of a good frame aerial may be of the order of 150 in the broadcast range of wavelengths; hence, in certain circumstances the effective voltage developed across a tuned frame aerial may be of the same order as that obtained from a fairly poor vertical aerial.

If the two vertical wires forming the loop aerial depicted in Fig. 5 are turned so that their plane is at right-angles to the direction of the wave, there will be zero phase difference between the EMF generated in one wire and the EMF generated in the other, hence there will be no resultant EMF between the two terminals. Thus, the frame aerial, as is well known, exhibits highly directional properties in which the signal strength is always at a minimum when the frame is placed at right angles to the direction of propagation.

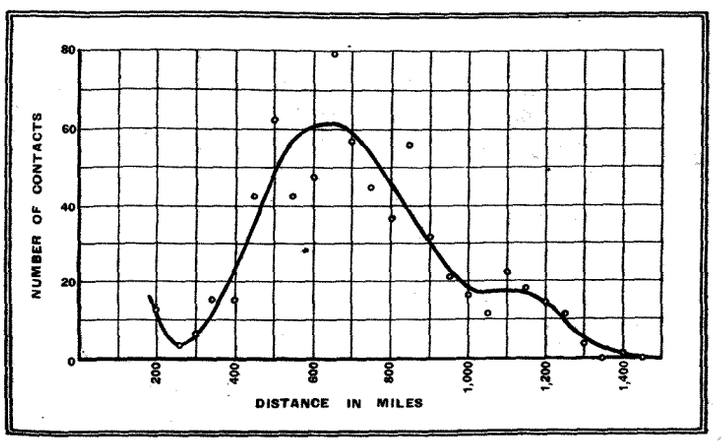
# Long-distance 5-metre Communication

## IONOSPHERE CONDITIONS NECESSARY FOR ITS ACHIEVEMENT

DURING the early part of the past summer reports began to reach the headquarters of the American Radio Relay League that 5-metre signals were being heard over exceptionally long distances and that for the first time Pacific and Atlantic coastal districts were exchanging messages on this wavelength.

It has long been thought that sooner or later some such results would be reported, but the probable skip distance was an unknown quantity.

By "skip distance" is meant the distance between the transmitter and the point at which the signals return to the earth's surface from the upper atmosphere, and again become audible.




**This curve, reproduced from *Q.S.T.*, shows the distribution (in terms of distance) of all reported long-distance contacts in the 56-60 Mc/s band.**

Perhaps it is only natural that the first definite indication that 5 metres may prove to be more than a purely local wavelength should emanate from America, for it is a vast country and has some 15,000 licensed amateur transmitters in addition to many keenly interested in the reception of short- and ultra-short-wave signals.

Although the results obtained on this occasion were admittedly due to exceptional conditions, there is no reason to doubt that they will be repeated.

The reports so far to hand have been co-ordinated in an article in the September issue of *Q.S.T.*, and certain deductions are drawn regarding the probable conditions prevailing in the ionosphere at the time.

A graph has also been prepared showing the number of stations heard at different distances. It was found that on June 5th, for which date the largest number of reports were available, that the apparent skip distance was about 600 miles, as it was at between 500 and 700 miles that the greatest number of stations were heard. This will be seen from the curve reproduced here.

Another interesting fact emerges, and that is the good reception obtaining at about 1,200 miles. Obviously, only tentative suggestion can be made at this juncture, but that given by the author of the article in question is that the bending of the waves takes place in the E layer, which on this occasion must have attained an exceptionally high ionisation level. The E layer is about 70 miles above the earth. It is stated that the normal ionisation rarely exceeds 200,000 free electrons per cubic centimetre, but the ionisation has at times been found to reach as much as five million electrons per cubic centimetre. Apparently, when this figure reaches one and a half millions, then conditions are ripe for 5-metre DX.

### Double Reflections

Reception at 600 miles is doubtlessly due to the reflected ray from the heavily ionised E layer, and the most likely explanation of the longer distance reports, i.e., 1,200 miles, is that the waves have made two excursions into the upper atmosphere. The first reflection brought them down at 600 miles; they were then reflected by the earth and were again subjected to a second bending, coming down again at the greater distance.

The fact that fewer observers heard 5-metre stations at this distance substantiates this view, as signals would be much weaker, and only those in possession of sensitive sets would pick them up.

Very exceptional conditions would have to obtain in order to satisfy the "double hop" assumption, since the high ionisation levels of the E layer must have extended over a very large area indeed.

A skip distance of 600 miles does not rule out the possibilities of 5-metre DX in this country, but, unfortunately, it places the areas in which the transmitters and receivers have to be situated in awkward parts of the country. For example, if the transmitter is near the south coast of England, then its reflected signals would be coming down to earth somewhere north of Perth, in Scotland. The west coast of Eire might just be favourable for receiving the reflected ray of a station located in the eastern counties of England.

These areas, unfortunately, are sparsely populated ones, which may account for the reason why 5-metre DX has not been reported so far on this side of the Atlantic other than an occasional report of the reception of an Italian station, and this may be an example of the "double hop" phenomenon. Taking 500 to 600 miles as the probable skip distance under exceptional conditions, then if we look southwards for suitable locations we again find the tract of country is not one in which many 5-metre stations are to be found.

Knowing a little more about the probable skip distance of these waves, it should be possible to make some arrangements between stations suitably related in distance for tests to be carried out over a period in order to verify the assumptions that have been drawn from a study of the reports obtained by the American amateurs.

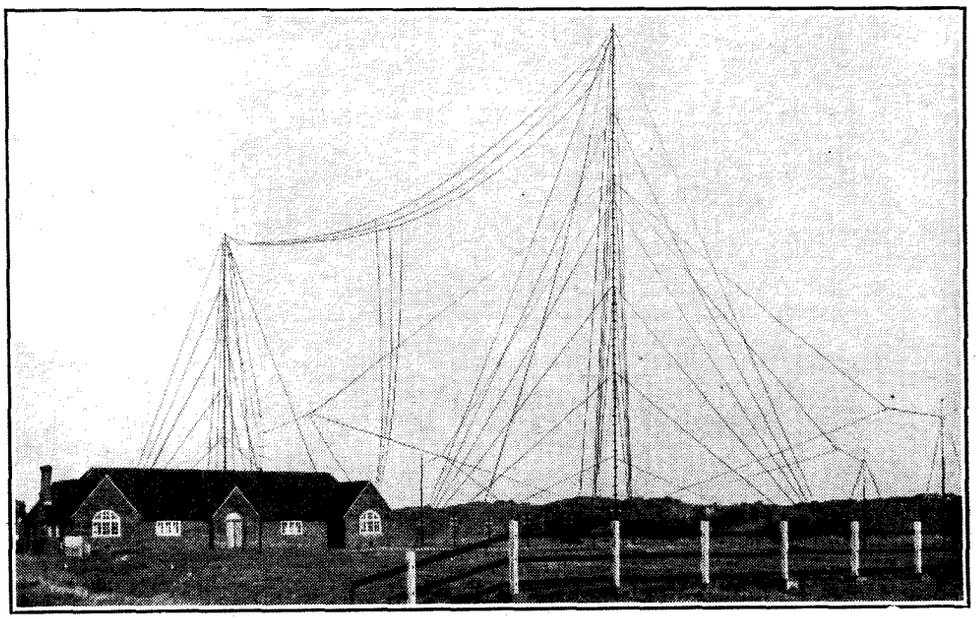
H. B. D.

# Humber Radio

*GKZ is perhaps best known as one of the Post Office stations which acts as a wireless link between telephone subscribers ashore and small craft at sea. It serves the fishing fleets working the Dogger Bank grounds in addition to conducting normal coast-station traffic with ships in the North Sea.*

## WIRELESS WATCH OVER THE DOGGER BANK

By J. AINSLIE



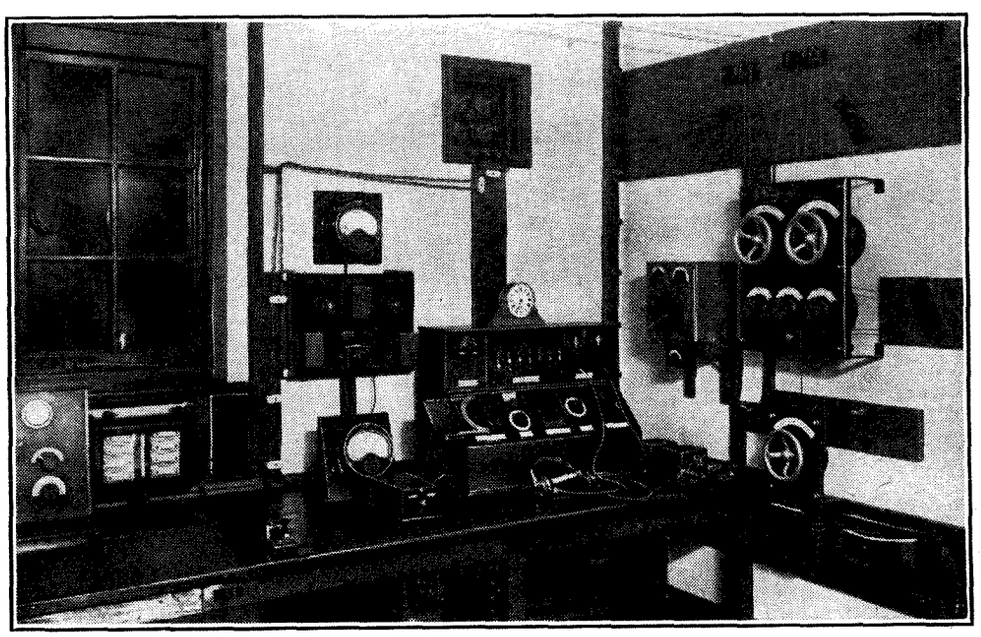
OPENED in 1927, Humber Radio (GKZ), on the Lincolnshire coast, replaced Grimsby Wireless Station, which, in turn, had taken the place of one of the pioneer coast stations—that at Caister-on-Sea, near Great Yarmouth. The Norfolk station had originally operated on a fixed gap spark transmitter and magnetic detector; Grimsby had an asynchronous spark gap and valve and crystal receiver. Humber Radio was equipped to operate on CW or ICW, and has since been fitted with radiotelephone apparatus, new receivers having been added from time to time in step with technical progress and service development.

In its early days Humber Radio was almost exclusively engaged upon mercantile marine morse communications on 500 kc/s, but it soon opened the first morse traffic service with British small craft—this was on 1,363 kc/s with the trawlers of a Hull firm fishing in the North Sea—and later carried out the first commercial radiotelephony experiments with similar ships on 1,850 kc/s. It was the first British coast station to be equipped with radiotelephone apparatus, and the first radiotelegram handled by a British coast station on radiotelephony was received at Humber Radio from the German ship *Nachtingarl* in 1928. That same year saw the development of regular small-craft RT communication schedules at Humber, and in February, 1937, the station was officially opened for simplex radiotelephone conversations between inland telephone subscribers and small vessels at sea.

Tubular steel masts support Humber Radio's aerial system, which includes Bellini-Tosi DF loops, and the earth system is the usual radial grid of buried earth wires. Its power supply is obtained from two 8-kW generators coupled to 14 h.p. semi-diesel engines in conjunction with 2-kW boosters and air-compressor starters. The associated 110-volt storage battery has a capacity of 300 ampere-hours.

There are three transmitters at Humber Radio: the "main" one (1.5 kW) is a CW/ICW unit operated on 1,520, 500 and 468 kc/s. The "emergency" (0.5 kW) is used on ICW on 1,520 and 500 kc/s, while the RT transmitter (0.3 kW), which is also capable of being used on CW/ICW if required, operates on 2,600, 1,837 and 1,650 kc/s.

The receivers in use are of the superheterodyne type, and reception can be carried on at a number of operating points at the same time. A continuous watch is maintained for morse ships on a frequency of 500 kc/s and a loud speaker watch on 1,650 kc/s for vessels fitted with radiotelephone apparatus. These watches are supplemented at frequent scheduled intervals by additional operator calling and listening periods—on 1,520 kc/s for small craft fitted with morse apparatus and on 2,012 kc/s for skipper-operated (RT) ships. The channels used for radiotelephone link communication purposes are 2,012 kc/s ship-to-shore and 1,837 kc/s shore-to-ship.



Direction-finding operating position at GKZ.

### Casualty and DF Services

The staff of eight operators and one handyman, under the control of the officer-in-charge, is responsible for the day-to-day running and maintenance of the plant. There are always two operators on duty, and, in addition to the handling of radiotelegrams, Humber Radio deals with maritime and aircraft casualties in its area—its flank stations are Cullercoats Radio (Northumberland) and Northforeland Radio (Kent)—transmits gale and navigation warnings on morse and telephony, gives wireless bearings and furnishes ships with weather reports and forecasts and medical advice upon request.

Humber Radio also maintains contact on radiotelephony with the Spurn and Cromer lifeboats and the Hull Conservancy Board's light-vessels. In the case of the lightships provision is made for the automatic calling of ship or coast station

**Humber Radio—**
when communication is desired; the transmission of a 1,000-cycle note operates a relay and closes a bell circuit. The local communication organisation also embraces radio contact with Trinity House fixed and mobile stations.

The number of ships which communicate with Humber Radio is of the order of 500 per week. The station's radiotelegram business is with ships trading between East Coast and Continental ports and with vessels engaged in the coasting and fishing trades. At Christmas, 1937, Humber Radio handled nearly 2,000 greeting radio-telegrams, and for the first time Christmas greetings were exchanged between small ships at sea and inland telephone subscribers; some two dozen such calls materialised. The reliable range of telephone communication as between small craft and an inland telephone subscriber is about 100 miles from the coast station, but much greater ranges are often obtained, and the greatest distance achieved by Humber Radio for radio link purposes is 1,100 miles—a long range, considering the low powers employed.

Communication with the inland system is maintained on teleprinter, with the usual morse stand-by, and by telephone lines, of which a special one is reserved for radiotelephone link communication purposes.

# UNBIASED

## By FREE GRID

### *The After-Effects of Manchester*

IT has been a tremendous relief to me to get rid of my beard and otherwise return to normal after the unfortunate series of circumstances attending my visit to the Manchester Exhibition. I am sorry to say that the process of removing the beard was attended by a regrettable misunderstanding. I boarded a London-bound train at the last moment, and unfortunately sprang into a non-corridor compartment, of which the sole occupant was a severe-looking spinster of Victorian vintage, who looked at me with such extreme disapproval that I forthwith tendered my apologies for intruding and promised to change compartments at the first stop.

I must say that I thought that my apology was accepted with rather an ill grace, but the incident soon passed from my mind as I became absorbed in a new book on direction-finding which I had picked up at the Exhibition. While reading, my beard annoyed me by continuously getting in the way and, without thinking, I drew a pair of nail scissors from my pocket and proceeded to remove it. I can well understand, of course, that such a practice must have seemed a little unusual to the lady, but there was, as I feel sure you will agree, no justification for her promptly pulling the communication cord as she did.

**Promptly pulled the communication cord.**

When the train pulled up and the guard came along, my appearance, with one side of my beard removed, must, I think, have biased his judgment, as at the next station I found myself handed over to the authorities. In the end I regained my freedom since, as I pointed out, there is no by-law forbidding a passenger to remove his beard on the company's premises; in fact, if I had been of a vindictive nature, I could have instituted legal proceedings for unlawful detention and probably have gained substantial damages. As it is, the only point at issue now is who is to pay the £5 for stopping the train? I have naturally disclaimed all responsibility, and the good lady who pulled the communication cord is refusing to pay on the ground that she did not pull it frivolously and without just cause as the railway authorities now maintain.

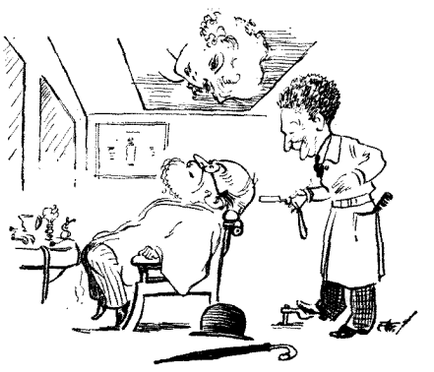
### *Television Viewing Revolutionised*

IT has been suggested in certain quarters that it would be a great step forward if portable extension television screens—or, in other words, cathode-ray tubes—could be provided for television sets so that we could put the picture just where we wanted it for viewing with the utmost comfort when sitting in our favourite armchair.

Now, as you all know, I am all for comfort, but at the same time I have got Mrs. Free Grid to contend with. I know that the necessary multiplicity of flexible connecting leads to feed an extension screen for each member of the family would not be likely to meet with her approval, more especially as the insulation of flexible leads always becomes frayed and worn after a bit of use. She makes enough song and dance when she accidentally catches hold of an exposed lead carrying the ordinary household voltage to the set, and I hesitate to contemplate her attitude towards the accidental charging up of herself to a potential of the thousands of volts which would be in the extension lead. The strain on her dielectric would, in fact, be only exceeded by that on her dialectic.

No, the only solution to the problem, in my opinion, is one which I encountered some little time ago when paying a flying visit abroad. Actually, as you will see by the accompanying sketch, the idea was developed by a barber for the purpose of entertaining his customers while they were being shaved.

Now, there is no reason at all so far as I know why the cathode-ray tube should not be permanently mounted in an upstairs room so that its screen end was flush with the ceiling of the room below, permanent lead-covered connections being made to the set. It may be objected, of course, that only people on one side of the fireplace could see the picture properly, the others having a sideways or even an upside-down view, but I have overcome that difficulty and intend submitting the idea to manufacturers—at a price, of course.



**Entertaining his customers.**

It would be quite easy for the whole picture to be rotated rapidly by electronic means similar to those used in the time-base. Owing to the persistence of vision phenomenon with which our eyes are happily blessed, it would be found that if it were rotated rapidly enough, and if, on the principle of a cinema film, its motion were momentarily arrested at each point of the compass, it would appear to be stationary and also the correct way up from whichever angle viewers looked at it. Now, pick holes in that if you can.

# Crystals

## CHECKING FREQUENCY BY MEANS OF QUARTZ-CONTROLLED RF OSCILLATORS

*A DESCRIPTION of the properties and applications of the quartz crystal, with detailed practical information on its uses as a stabilising element in oscillators.*

By H. B. DENT

IF one mentioned the word crystal a matter of ten years ago most wireless-minded people knew you were referring to one of the many forms of crystal detector, which even at that time was becoming a rarity. To-day, however, the word conveys quite a different meaning, having nothing to do with the detection of wireless signals, but referring to those crystalline substances that possess what is known as piezo-electrical properties.

If a piece of any crystal that comes within this category is subjected to a mechanical strain of such a nature that the crystal is distorted, such as a force tending to twist the crystal, it is found that an electric charge appears on the crystal. Conversely, if a difference in potential is applied to two opposite faces of a slab of the substance there will be a twisting or distorting strain in the structure of the crystal. The amount of distortion in the crystal will be dependent on the magnitude of the applied voltage.

This is a very interesting phenomenon, and, recently, means have been found for utilising it in connection with certain pieces of wireless and kindred apparatus.

For example, slabs of these crystals are mounted in a holder and it is arranged for the slabs to be mechanically distorted by a diaphragm whenever sound waves impinge on it. When this happens a difference in potential appears on opposite faces of the crystal which will vary in magnitude with the movements of the diaphragm. These voltage variations can be amplified and one then has a microphone which, if the mechanical parts are light enough and suitably designed, will possess an excellent response characteristic.

The same general principles are now applied to the construction of gramophone pick-ups and also to loud speakers.

Of the many substances that exhibit this property, Rochelle salts and quartz are the two most generally used, the former mainly for microphones, pick-ups and loud speakers and the latter for frequency stabilisation.

### Stability and Constancy

Quartz is used for frequency control as it is an exceptionally hard material with great mechanical stability, while its structure is unaffected by ordinary atmospheric changes.

If a plate of quartz is cut so that its major plane bears a certain relation to one of the axes of the mother crystal it is found that the plate is capable of maintaining an oscillatory circuit at a definite frequency. Thermal changes in the valve and associated circuit and the fluctuations in HT voltage that under ordinary conditions of operation would cause the frequency to drift are rendered inocuous when the crystal is employed. Furthermore, the circuit can be so arranged that oscillation is produced only at the fundamental "oscillating" frequency of the crystal, which then takes complete charge.

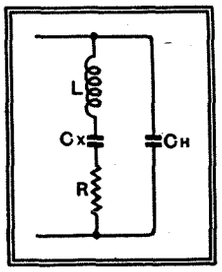



Fig. 1.—The equivalent electrical circuit of a quartz crystal. L represents the mass of the crystal, Cx, its resilience, R, frictional losses when vibrating, and CH the capacity of the crystal in its holder.

The mechanism of the crystal when used in an oscillating circuit may be regarded as similar to that of a tuned circuit having a very high Q value. Its electrical equivalent is an inductance, a capacity and a resistance joined in series, the whole being in shunt with another capacity formed by the crystal and the two metal plates between which it is customary to mount it. Fig. 1 shows this equivalent electrical circuit.

The inductance L is the mass of the crystal, Cx is its resilience and R is the frictional loss when the crystal is vibrating, i.e., oscillating, while CH is the parallel capacity formed by the crystal in its holder.

Actually, this circuit can have two fundamental frequencies, one being produced when L and Cx form a series resonant circuit and the other when the combined reactances of L and Cx are inductive but equal to that of CH, so forming a parallel resonant circuit. This is slightly higher than the series resonant frequency and is the condition of operation adopted in an oscillating circuit and is consequently given as the fundamental oscillating frequency of the crystal.

It would appear from this that the frequency of an oscillating crystal can be changed by varying the position of one or both contact plates and within certain limits this is possible. Normally, these plates are in contact with the crystal and very slight spacing of one will raise the frequency.

Merely spacing one plate is not a practical solution as precautions must be taken to prevent even the minutest movement of the crystal when so mounted, as this will affect its frequency and so render it useless for control of an oscillator. Actually, mechanical means have been found to embody the variable frequency feature in a crystal mounting, such a unit being made by the Bliley Electrical Co., of Erie, Pennsylvania, U.S.A.

### Low Losses

The high Q of a crystal comes about by the fact that its mechanical equivalent to L is very large, while the R, frictional loss, is very low so that the $\frac{2\pi fL}{R}$ factor becomes far and away larger than can be obtained with any ordinary tuned circuit. Possibly the nearest approach to it, at least at the higher radio frequencies, would be one of the spherical forms of a tuned circuit.

Crystal cutting and grinding is a specialised business, so that there is no useful purpose to be served by describing the different types of cut employed, save to say that some produce crystals having better temperature coefficients than others. By this is meant the change in fundamental frequency of the crystal that occurs with change in temperature.

A valuable property of the crystal is that of holding an oscillating valve at a constant frequency; furthermore, the frequency is solely determined by the crystal. We are thus provided with a valuable means for calibrating test oscillators.

It might be said that an oscillator giving a single frequency is of little use, and were one to rely on the fundamental frequency alone admittedly its utility would be limited. The usual practice is to choose a fundamental frequency for the crystal that enables its harmonics to be used for checking or calibration. If, for example, we decide on 100 kc/s for the fundamental of the oscillator, then the harmonics produced will be at 200, 300, 400, 500 kc/s and so on up to about 1,000 kc/s. With a fairly strong oscillator and a suitable detector no difficulty will be experienced in identifying the harmonics up to the tenth. Thus we have ten known frequencies covering the medium and long broadcast wavelengths. From these it is quite easy to draw a calibration curve of the test oscillator, or, alternatively, the harmonics could be used as spot frequencies for testing and checking the calibration of a wireless set.

The equipment required for checking a signal generator is shown diagrammatically in Fig. 2. The actual values of the components and the setting up of the

**Crystals—**

crystal oscillator will be dealt with later. What actually takes place in this circuit is that RF voltages are injected simultaneously into the detector from the signal generator and from the crystal oscillator and the beat note rectified and made audible in the headphones. The coupling between L1 and L2 should be variable, as it will have to be quite loose at the fundamental, second, third and possibly fourth harmonics and tightened for the higher harmonics, which will naturally be weaker. With care it is possible to pick out harmonics well beyond the tenth, but their identification becomes increasingly difficult as their separation is only 100 kc/s.

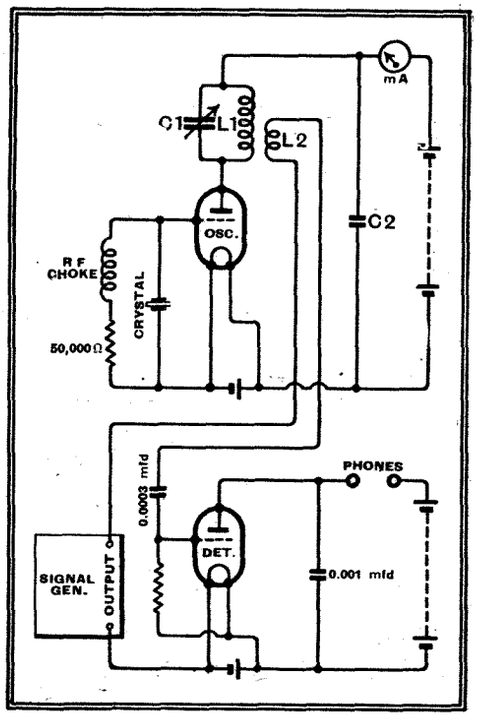



**Fig. 2.—Method of using a low-power crystal-controlled oscillator to check the frequency calibration of a signal generator.**

For frequency checking on the short-wave bands it would be better to employ a crystal of, say, 1,000 kc/s or higher. This would provide at least ten additional and easily identified spot frequencies at 1,000 kc/s separation up to 10 Mc/s (i.e., 30 metres) or still further into the short-wave region by the exercise of a little care in picking out harmonics beyond the tenth.

In setting up the oscillator it is most important to avoid overloading the crystal. Since many harmonics are required a fairly powerful oscillator has to be used and the RF current through the crystal may reach a magnitude sufficient to damage it. One must remember that the crystal actually vibrates at its fundamental frequency and if these vibrations exceed a certain amplitude the crystal will be fractured.

It is customary for all oscillating crystals to be given a maximum safe RF current rating, or, alternatively, the safe operating conditions are fixed by placing a limit to the HT voltage applied to the valve, the type of which is specified.

Where a figure is given for crystal current it can be kept within the stated limits by including a small flash lamp in series with the crystal, as shown in Fig. 3. This lamp can be roughly calibrated beforehand on DC and the intensity of the glow noted for different values of current. With most crystals a low-consumption type of lamp will have to be used. It is wisest always to commence with a reasonably low value of anode voltage and then to increase it until the maximum safe current is flowing through the crystal.

It is hardly likely that with a frequency checking oscillator the power supplied will come anywhere near the safe limit for the crystal, but it is well to be aware of these matters all the same. Furthermore, if the oscillator is of the self-biasing kind as in Fig. 2, where the rectified DC component of the RF develops the biasing potential across the 50,000-ohm grid resistance, the anode current may reach a dangerous value at the full HT voltage when the valve is not oscillating.

In the case illustrated in Fig. 3, which shows a pentode oscillator, a standing bias is provided by the cathode resistance R2, while additional bias is produced by R1 when the valve starts to oscillate. In this case R1 can have a value of between 10,000 and 25,000 ohms.

## Multi-electrode Valves

Pentode or tetrode oscillators have the advantage that greater RF power, and hence stronger harmonics, can be generated for a lower crystal current than is the case with triodes.

To obtain powerful harmonics a high L/C ratio should be employed in the tuned circuit; that is to say, a large inductance and a relatively small capacity.

When tuning the pentode oscillator it will be found that on swinging C2 through the resonant frequency of the crystal there will be a sudden reduction in anode current, this condition obtaining so long as the valve oscillates.

If the capacity of C2 is reduced progressively from maximum a point is reached where the anode current meter kicks sharply downwards, denoting the start of oscillation, but with further reduction in the capacity of C2 the rise in current as indicated by the meter is much slower. The condition is shown by the curve in Fig. 4, the high level indicating non-oscillation and the sudden dip the oscillating condition.

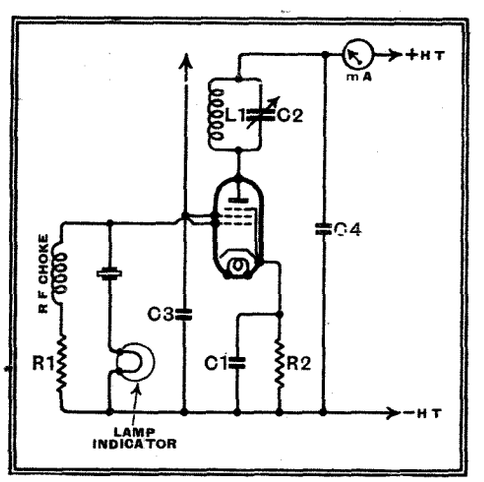



**Fig. 3.—Powerful harmonics can be generated by a pentode crystal-controlled oscillator. The lamp gives an indication of the RF current flowing through the crystal and thus serves as a monitor for overload.**

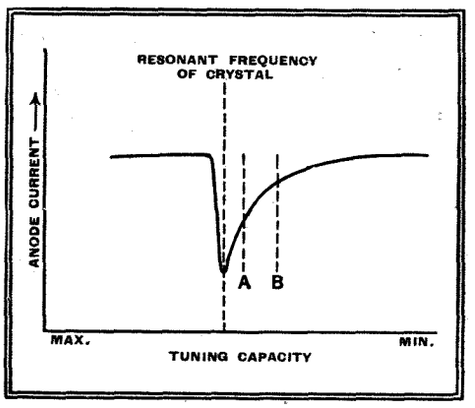



**Fig. 4.—Change in anode current in a crystal-controlled oscillator takes this form when the tuning condenser is swung through resonance. Most stable operation is obtained between points A and B on curve.**

Though the greatest RF power will be generated with the anode circuit tuned for maximum current dip, this is not the best adjustment for the oscillator, as it is inclined to be somewhat unstable, for, as will be seen from Fig. 4, any external influence that adds capacity to the anode circuit will stop the valve oscillating. The best adjustment of the anode circuit is slightly off resonance, but on the *higher frequency* side so that the anode current lies between the points A and B on the curve.

By using another oscillator, or an oscillating detector valve, to heterodyne the output of the crystal oscillator it will be found that the tuning condenser C2 can be varied over the range where oscillation continues without any noticeable change in the heterodyne note. Thus its frequency is independent of the tuning of the anode circuit.

The only setting that will produce any discernible change in frequency is on the dip of the curve just to the left of A (Fig. 4), for just before the valve ceases to oscillate it becomes sensitive to changes in the anode circuit tuning, which is another reason why the oscillator should not be operated at this particular adjustment of C2.

There are, of course, other applications for the quartz crystal, and oscillators of the kind described, or variations of them, are used extensively in amateur transmitters for frequency stabilisation. Often this involves stepping-up the frequency in order to stabilise, say, a 10- or 5-metre transmitter by a crystal ground for one of the longer amateur wavelengths. Crystals are also used to obtain very high selectivity in receivers as was explained in a recent article in *The Wireless World* of September 15th last dealing with crystal band-pass filters.

# NEWS OF THE WEEK

## "B.H." STILL A CITADEL

### A.R.P. Fitments to Remain

ALTHOUGH the programmes are resuming their normal aspect, Broadcasting House is still a sand-bagged citadel. In fact, the Corporation, having filled several hundreds of sacks with loam collected from the grounds of a convent in Maida Vale, is wondering what to do with them.

The steel doors recently installed in corridors below ground level will remain in position for some time to come, and it is probable that similar fitments will be included in the extension building to be erected in Portland Place.

#### *. . . And the Control Room*

The circuits for by-passing the control room to provide direct communication between an underground studio and the Regional transmitters will remain permanent. For this reason no plans have been made for removing the existing control room on the eighth floor despite its exposed position. For all ordinary purposes the control room is ideally situated, with ample light, fresh air and space to work in without cramping, and it is doubtful whether any other part of the building would provide the same facilities.

## ONE LICENCE PER SET

### A Radio Industry Approaches Crisis

THE Danish radio industry attained an unprecedented output record to the value of £1,000,000 last year, but it is now estimated that in view of the approaching saturation point the number of licence holders is unlikely to rise by more than about 70,000 over the present figure.

It will take little more than half a year's production to supply the newcomers with receivers, and the trade is contemplating a propaganda campaign similar to the English scheme of "Two Sets Are Better Than One."

This project cannot be realised unless the Radio Licence Office revises its present demands, which call for one licence per set, and it is expected that representations will be made to the Government by representatives of the Danish radio manufacturers.

## AMERICAN TELEVISION

### New Transmitter for the C.B.S.

A HIGH-DEFINITION television transmitter is being installed by the Columbia Broadcasting System on the 72nd and the 73rd floors of the Chrysler Tower in New York. The transmitter, the total cost of which is estimated at more than £130,000, is expected to provide a reliable service within a radius of 40 miles. The aerial, specially designed for an even distribution of signals, consists of 8 independent dipoles for vision radiation and 8 for sound.

The power input to the transmitter will be 300 kW, and a comprehensive system of safety devices will be installed for the protection of engineers.

#### *Safety Precautions*

All doors leading to the transmitter room proper, as well as all panels over high voltage equipment, will carry interlocked switches to cut off power automatically when the doors or panels are opened. A further precaution is the "shorting plug" arrangement. An engineer going to work behind a panel takes one of these plugs with him, thereby disconnecting the circuit. On the master control desk a panel of 20 control lamps flashes the exact location of any operator working near high-voltage equipment.

The new transmitter will operate under the call letters W2XAX, and will supplant the low-power equipment which has been used for experimental purposes at Columbia's television laboratories in the C.B.S. building at 485, Madison Avenue.

## A BROADCAST HALL

### Designed for Broadcast Listening

B.B.C. engineers and the British Film Institute co-operated in designing the new broadcast hall—the first of its type in this country—which was opened at Trinity College, Carmarthen, last Friday.

The cost of the hall, with other extensions, was £12,000.

To enable students to hear broadcast programmes under ideal conditions, the B.B.C. Research Department prepared plans for a hall in which the acoustic conditions combined all the best features of the principal B.B.C. studios at Maida Vale and in the provinces with facilities for adjusting reverberation periods in accordance with the size of the audience. Undesirable resonances can also be suppressed.

## B.B.C. SALOON CAR

### New Recruit for the Recording Unit

TO meet the need for a vehicle that at a moment's notice could swiftly go anywhere to collect "actuality" material for news bulletins in the Home and Overseas programmes, a 21 h.p. saloon car has been recruited for the B.B.C.'s mobile recording unit.

Manned by a crew of three, the car is equipped with portable recording apparatus comprising a motor-generator and switchgear, an amplifier and five-way mixer, and a turntable and tracking mechanism. A hundred yards of cable for telephone communication and a similar length of cable for the microphones (those used are normally of the moving-coil type) are also carried.

The car was put into service on the occasions of Mr. Chamberlain's journeys to and from Germany, and the recordings which listeners later heard in the B.B.C. news bulletins were part of its work.

## STILL THE IDEAL MICROPHONE VOICE

NO greater tribute could have been paid to Stuart Hibberd than in the statement from Cardiff that the Welsh Region is in quest of a "silver-tongued" announcer who will be to the Region what the senior announcer is to British listeners as a whole.

With nine announcers now at work in home programmes at Broadcasting House, it is still considered that no voice is comparable with Mr. Hibberd's. So far, the search for a Welsh Hibberd has proved fruitless.

## "YOUR TELEVISION SET"

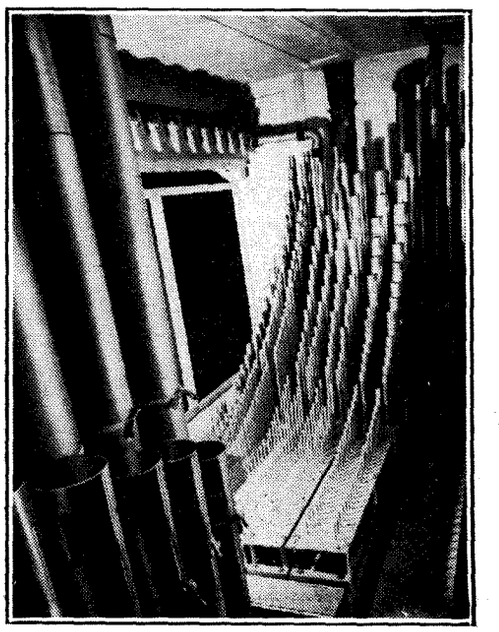
### Lectures from Alexandra Palace

MOST viewers find the operation of their receivers quite simple, but whether they make the greatest possible use of the controls is another matter. On October 24th Mr. T. H. Bridgewater, Senior Maintenance Engineer at Alexandra Palace, will give the first of two illustrated talks on "Your Television Set." Showing various types of receiver, he will demonstrate how the best can be got out of each, explaining in simple terms the general layout of the sets. Although such talks may savour of "preaching to the converted," it is hoped that much of the information will be useful to regular viewers. The second talk will be given in November.

## B.B.C. FOREIGN BULLETINS

### Reports of Widespread Interest

ALTHOUGH for obvious reasons there has been no "fan mail" from Germany in respect of the nightly bulletins transmitted in German from the B.B.C. Regional stations, the Corporation has reason to believe that reception in Western Germany was fairly widespread. The most interesting reports have come from travellers arriving at Croydon Airport with the news that the bulletins were being eagerly followed by an increasing number of listeners. Despite efforts to distribute the People's Set throughout the Reich, it appears that a relatively small number of these insensitive



**MAIN CHAMBER of the B.B.C. Theatre Organ, which will be the subject of a second conducted broadcast tour by Reginald Foort in the Regional programme on Friday at 9 p.m. The picture shows the vast range in pipes and listeners will again hear a run up the scale from the largest to the smallest.**

**News of the Week—**

receivers are actually in use. The Goebbels - Rundfunke - Spende Institute reports that 22,242 sets of this type have been issued, together with 60,000 spare parts, including valves, and this cannot be considered a large number in relation to Germany's eight million licence holders.

The average German listener with a reasonably sensitive and selective set has no difficulty in picking up the British stations.

## STAFF REMINISCENCES

### Sidelights on Sir John Reith

SIR JOHN REITH'S departure has opened the flood-gates for a flow of reminiscences in the current issue of the B.B.C.'s staff magazine, *Ariel*.

Arthur Burrows, now of the U.I.R., writes of the early days: "The working hours of the seniors were in the neighbourhood of fourteen per day. We kept dress clothes in a kit-bag lest we might be required to dine with someone."

Mungo Dewar, who was Assistant Station Director at 5SC, Glasgow, in 1923, describes how Sir John (then Mr.) Reith came to the rescue at a critical time. "Everything between the General Manager and his staff in those days was a very personal affair. For several weeks at the beginning I received no salary, and when he asked me on one occasion what I thought about the licence question, I replied: 'Not much, because I've had no salary for weeks!' However, I'm glad to say the salary, not the licence question, was rectified in a day or two."

Sir John Reith's passion for moving the furniture about is referred to by Miss Elizabeth Nash, his former secretary. "Having filled me and others up with enough work to last a week," she writes, "he would suddenly decide that the furniture must be changed round, and we would all work at it till we were hot, dusty and tired, and every telephone had been pulled out by the roots. . . . And there were days when he would tease and plague us till I could willingly have brained him with his own walking stick. . . . Great times, happy days!"

## DAVENTRY RECEPTION IN AUSTRALIA

WITH the approach of summer "down under," the Daventry Empire broadcasts are coming into favour again, particularly the No. 2 transmission. GSF, GSO, GSH and GSJ are scheduled to open at 8.45 p.m. in Sydney (10.45 a.m., G.M.T.). For some months they have been inaudible during the three hours of the broadcast; but since the end of August, according to reports received at Broadcasting House, Daventry "has been a delight to listen to," particularly GSG, GSJ and GSH. The first-named is at full speaker strength from 8.45 to 11.45 p.m., with GSH slightly stronger than GSJ; but GSJ becomes very strong after the first hour. As the Australian summer approaches, superb reception can be guaranteed on any one of these three wavelengths, namely, GSJ, 13.93 metres; GSH, 13.97 metres; and GSG, 16.86 metres.

### N.P.L. DIRECTORSHIP

THE Department of Scientific and Industrial Research announces that the Lord President of the Council has released Professor R. H. Fowler, O.B.E., F.R.S., at his own request for reasons of health, from the engagement to assume the Directorship of the National Physical Laboratory on October 1st, in succession to Dr. W. L. Bragg, O.B.E., D.Sc. To the vacancy thus created the Lord President has appointed Dr. C. G. Darwin, M.C., Sc.D., F.R.S., Master of Christ's College, Cambridge. For the period until Dr. Darwin can assume his duties, the Lord President has decided that the office of Director shall be held by Sir Frank Smith, K.C.B., C.B.E., Sec. R.S., the Secretary of the Department of Scientific and Industrial Research. Correspondence should be addressed as hitherto to the Director, National Physical Laboratory, Teddington, Middlesex.

## *FROM ALL QUARTERS*

### Newfoundland Station

A 10-kW wireless transmitter is being assembled at Montreal by the Canadian Marconi Company for the Newfoundland Government. It is to be erected near St. John, Newfoundland, and will be controlled by a body similar to the Canadian Broadcasting Corporation. Commercial programmes will, it is expected, form a part of the transmissions, and the inauguration is to take place early next year.

### ZB2...., Gibraltar

AMATEUR transmitting licences are at last being granted in Gibraltar, where the prefix ZB2 has been allocated. Local enthusiasts have been endeavouring for many years to obtain permission for amateur transmissions there, and the same difficulty was experienced in that other naval stronghold, Malta, when amateur transmitting permits were first applied for, but now there are a dozen or more amateurs using the ZB1 prefix there.

### High Power Project

NORWEGIAN broadcasting authorities are planning to increase the power of the present 60-kW, 1,153.8-metre Oslo transmitter to 300 kW and to move the station to a more central site in East Norway. Reference to the lists of principal broadcasting stations of Europe shows that such a change would make the station second only to Moscow I in power.

### Safety Mark

THE French Union of Registered Manufacturers in the Electrical Industry published, in 1936, a booklet which enumerated the technical requirements of all electrical appliances placed upon the market. The safety system will come into effect at the end of this year, and all goods complying with its specifications will bear the stamp "Marque de Sécurité U.S.E."

### U.S.A. Radio Festival

SINCE 82 per cent. of all U.S. homes have a wireless receiver, and sales to the remaining 18 per cent. cannot sustain the enormous American industry, it is suggested by our contemporary, *Radio Retailing*, that a National Radio Festival should be inaugurated in an endeavour to convince existing owners of the superior quality of the new models. It may be recalled that a National Radio Week was held in this country a few years ago, but not with any marked success.

### School Radio in Australia

MORE than 1,500 Australian schools are now equipped with receivers. These cater for approximately 50,000 children, and arrangements have been made for schools to submit weekly reports on broadcasts.

### Tunis Tests

THE new French station, Tunis PTT, has been conducting daily tests from 11 a.m. to 1 p.m. and 6 p.m. to 8 p.m. on a wavelength of 345 metres, with a power of 30 kilowatts.

### Institution of Electrical Engineers

DR. A. P. M. FLEMING, C.B.E., M.Sc., the President, will give the inaugural address at the opening meeting of the 1938-39 session of the Institution at Savoy Place, Victoria Embankment, London, W.C.2, at 6 p.m. on Thursday next, October 20th.

### New R.C.A. Director

MR. E. F. MCGRADY, Vice-President and Director of Labour Relations of the Radio Corporation of America, was recently elected to the Board of Directors to fill the vacancy created by the death of Mr. J. R. Sheffield.

### Postponed Exhibition

THE International Radio Exhibition, which was to have taken place in Lyons from October 1st to 10th, was postponed owing to the political events of recent weeks. The Exhibition, which was opened on October 8th, will now remain open until October 18th.

### Bombers Hit by Lightning

THE wireless operator of an R.A.F. Harrow bomber was thrown away from his instrument board and the wireless apparatus put out of action when the 'plane was struck by lightning during a storm over the Channel last week. The crew of five were forced to abandon the machine, which crashed near Rye. At approximately the same time a similar accident occurred to another R.A.F. 'plane engaged on night flying exercises over Yorkshire. The crew of this machine also made parachute descents in safety.

### Royal Variety

THE Royal Command Variety to be given at the Coliseum on November 9th will not be broadcast. This decision was reluctantly arrived at by the B.B.C. and leading representatives of the stage in the face of evidence brought forward by the Theatrical Managers' Association and the Cinematograph Exhibitors' Association, which showed that the broadcast of the performance in 1937 had a serious effect on the business of all places of public entertainment.

### Electro-Encephalography

A FRENCH report states that the Salpêtrière Hospital, Paris, has recently been equipped for electro-encephalography (graphical representation of the brain's voltage variations) by Dr. Ivan Bertrand. The apparatus is used for the diagnosis of cerebral tumours and epilepsy, and similar apparatus designed by Mr. Grey Walter, of London, was described in these pages in our issue of March 24th.

### Director of Religion

THE B.B.C. announces that the Rev. J. W. Welch, Ph.D., will succeed the Rev. F. A. Iremonger, D.D., as Director of Religion from April 1st, 1939. Dr. Iremonger, who is retiring, has been in charge of the Corporation's religious work since May, 1933.

### Push-button Tuning

IT is understood that at a recent meeting of the Nebraska Broadcasters' Association a protest was addressed to the radio manufacturers asking them to discontinue making push-button receivers. The reason given for this protest was that it would tend towards making people listen to a few set stations, and the independent local advertising stations would suffer because of the lack of potential listeners.

### Radio Nottingham

IT is probable that the B.B.C. exhibits made for the Empire Exhibition at Glasgow will be on view some time in Nottingham next year. Licence numbers in that town now stand at 121,847, an increase of 7,034 during the past twelve months.

### The Interference Problem

THE Metropolitan Boroughs' Standing Joint Committee has decided to approach the London County Council with the object of obtaining Parliamentary powers to suppress electrical interference from neon signs in the Metropolitan area.

# Neon-Controlled Stabiliser

## A CONSTANT-VOLTAGE RECTIFIER UNIT

By H. J. N. RIDDLE and F. A. DOWNES, A.M.I.E.E.

*THE device described in this article, though developed for non-wireless purposes, is applicable to apparatus needing a constant HT voltage independent of mains fluctuations. The peculiar properties of a neon lamp are used to control the rectifier grid voltage.*

THE stabiliser which is described in this article is capable of providing a constant output, adjustable between the approximate limits of 250 and 300 volts, free from excessive ripple, and will deliver a current of 10 milliamps over prolonged periods. The device, as described, has been thoroughly satisfactory in use, and the valve used for rectification and stabilisation has been approved by the valve manufacturers as suitable for operation over lengthy periods. The apparatus was originally designed to supply the timing circuits in vehicle-actuated road traffic signal controllers, where a very high degree of accuracy of timing is essential even with AC supply fluctuations of ±15 per cent.

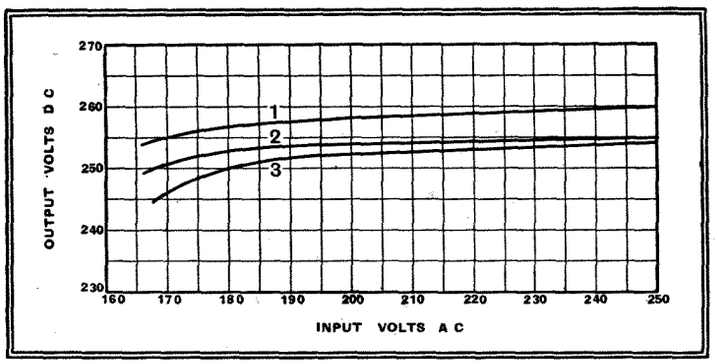



Fig. 1. Showing how the stabiliser-rectifier described maintains a sensibly constant output DC voltage over a wide range of input AC voltage variations. The curves were taken with different neon lamps.

Fig. 1, curves 1, 2, and 3, shows how the output of the stabiliser-rectifier varies with the AC input. From the curves it is seen that if the AC input is varied by, say, ±10 per cent., the output varies to the extent of less than ±2 per cent. A control knob is fitted to the unit so that a stabilised output of suitable voltage can be obtained, and an input transformer enables the unit to be connected to supplies of 200 to 250 volts nominal.

Essentially the stabiliser is a single-wave rectifier employing an evacuated thermionic valve similar to the common diode single-wave thermionic rectifier with the exception of a control grid which plays an important part in the stabilising function.

The rectifying valve has a robust filament, with an emission far in excess of actual current requirements, and the filament is supplied with alternating current at about 4 volts. The transformer supplying heater current also has a high-tension secondary winding for providing the current which is rectified in the anode-cathode circuit of the valve.

Ignoring for the moment the grid, Fig. 2 shows the whole of the circuit details concerned with the rectifying function. Such a simple rectifier operates as follows:—

In common with all thermionic valves, current is able to pass through the valve so long as the anode is positive with respect to the cathode (filament), but if, and for as long as, the anode is negative with respect to the cathode, no current is able to pass through the valve. The alternating output from the secondary of the transformer being applied to the anode and (via condenser C1) cathode results in an intermittent flow of current which commences and finishes when the anode becomes alternately positive and negative. Each current flow or pulse results in the raising of the voltage in the condenser C1, and, these rises being additive, the condenser acquires a high charge, the electrode connected to the cathode becoming continually positive, and that connected to the transformer output negative.

As soon as the potential in condenser C1 rises to the peak or maximum value of the alternating potential of the transformer output the anode of the valve fails to become positive during any part of the cycle, but, on the other hand, it becomes negative with respect to the cathode at one point in the cycle to the extent of the numerical sum of the potential in the condenser and that across the transformer output. When this state is reached, no further current passes through the valve, and the potential of the condenser rises no higher. However, if some current is taken from the condenser C1, its voltage will fall as a result, and further pulses of current will pass through the valve. If a continuous current be taken from the condenser, its potential will drop steadily as a result, but will tend to be raised with each current pulse. For this reason the potential across the condenser will rise and fall in the manner shown in Fig. 3. Such a mode of operation is simply that of an ordinary single-wave valve rectifier; it merely remains to add that a choke L and further condenser C2 is provided so that the accumulated DC potential in C1 may be available with the pulsations or ripple reduced to a negligible amount.

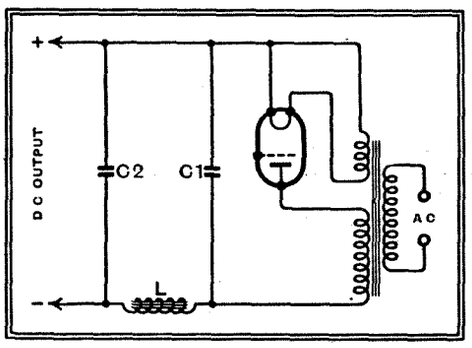



Fig. 2. A conventional half-wave rectifier; the valve grid is inoperative.

### Grid as Stabilising Control

It can be shown that whilst the value of the DC voltage will vary according to the load imposed on the DC output, if such a load be kept constant the DC voltage will be roughly of direct proportion to the AC input so long as the filament is hot enough to emit a sufficient number of electrons. Therefore, such a recifier does not in itself show any stabilising tendencies. If, however, each current pulse from the valve could be stopped at the instant when the voltage across the condenser C1 had risen to some exact value, the tendency to give longer and stronger impulses to the condenser C1 in the event of the supply voltage rising would be prevented. The valve grid provides a means of interrupting at any instant the anode-cathode flow, and the neon tube provides a means of detecting the instant at which the voltage in the condenser C1 rises to a predetermined point. Actually, this grid has little or no effect so long as its potential is not

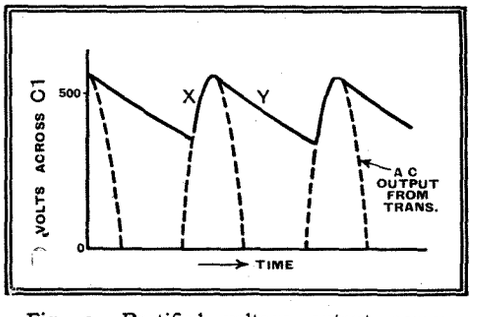



Fig. 3. Rectified voltage output across C1 in Fig. 1. At point X voltage is rising, due to current passing through the rectifier, while at point Y it is falling on account of the load.

**Neon-controlled Stabiliser—**

negative with respect to the cathode, but if made negative to the extent of about 50 to 100 volts no current can flow through the valve even when the anode is positive with respect to the filament. The neon tube possesses a peculiar characteristic, by which it remains an insulator so long as the potential applied to it is less than a certain critical value, but if this critical voltage is exceeded even to the extent of a fraction of a volt the tube becomes a good conductor of electricity, and, moreover, remains so until the potential across it is reduced very considerably. Thus, if the voltage across the tube used in the stabiliser-rectifier be gradually raised, no current will pass through it until

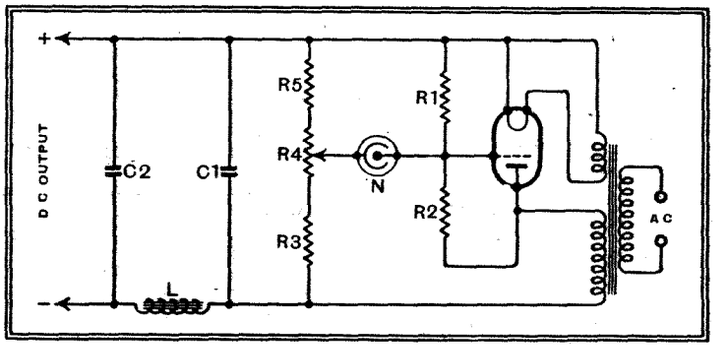



Fig. 4. Circuit diagram of the stabiliser-rectifier. R1, 0.5 megohm ; R2, 1.5 megohms ; R3, R4, 25,000 ohms ; R 5, 50,000 ohms ; C1, 4 mfds ; C2, 16 mfds ; L, smoothing choke.

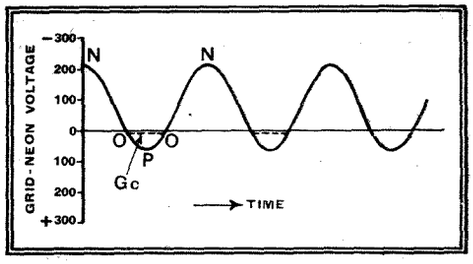



Fig. 5. Voltage changes developed across the neon tube, and applied to the grid.

the voltage reaches a value of about 170 volts, at which it "strikes" and becomes a good conductor. Whilst in the "struck" condition the voltage can be lowered to about 100 volts, at which point the tube "extinguishes" and once more becomes a non-conductor. The subsequent raising of the voltage to 170 will once more cause the tube to strike.

The manner in which the controlling propensity of the grid in the valve and the peculiar characteristic of the neon tube are combined to result in the stabilising of the output of the unit will now be described with the help of Fig. 4.

Since neither neon tube electrode termination remains at constant potential with respect to any other point in the circuit during the cycle of events, it is necessary for a clear understanding of events to refer the potential of either of these electrodes to the cathode of the valve, which is at all times considered to be at zero if not earth potential. First consider the potentials occurring at that point where the neon tube is connected to the grid of the valve. A resistance R1, Fig. 4, connected between this point and the cathode tends to maintain a constant zero potential, but another and much higher resistance connected to the anode tends to make the grid and neon electrode potential follow the anode potential. The ratio of the resistance values R1 and R2 will determine what ratio the grid potential will tend to be of the anode potential, and in practice, the resistance R2 being about three times that of R1, the potential at the grid will tend to be about one-fourth of the anode potential. The anode voltage at a given instant can be taken to be the numerical sum of the instantaneous voltage across C1 and that of the transformer secondary. The voltage at the grid, therefore, tends to follow this, but at one-fourth value, and a typical example is shown in Fig. 5 (Curve NOPON). As soon, however, as the grid becomes even one or two volts positive, it passes current and almost the whole of the positive potential is dropped across R2, giving the effect shown in curve NOG*c*ON. When the grid is rendered negative by R2 no current flows through the valve from grid to cathode, and the grid and neon electrode follow the one-fourth anode voltage exactly.

Consider now the other termination of the neon tube. This is connected to a potentiometer which applies a proportion of the potential across C1 to the neon electrode. The reason for this potentiometer will be explained later, but it can be assumed that the potential applied to the neon electrode is between three-fourths and one-half of that across the condenser C1.

## Saw-toothed Waveform

It has been seen that the voltage across the condenser C1 follows some such curve as Fig. 3. Actually, the voltage applied to the neon electrode will be of approximately saw-toothed form.

It is now possible to determine the voltage between the electrodes of the neon tube at any instant by relating this waveform with the curve of Fig. 5 (NOG*c*ON). The distance between the two curves at any moment will represent the voltage between the neon tube electrodes. This is shown in Fig. 6, from which one or two important facts can be observed :

(1) During the time when the anode is positive, the voltage of C1 rising and the neon tube voltage approaching striking point, the grid-neon electrode potential is maintained virtually at zero potential by the flow of grid current. The voltage changes across the neon tube during this period are, therefore, due to, and are strictly proportional to, the voltage across C1. The value of the AC voltage input to the transformer has, therefore, no bearing on the matter, and, high input or low, the neon tube striking voltage is reached when the voltage across C1 has reached a definite value. Thus the grid is made negative to the extent of about 100 volts by the striking of the neon tube, and the voltage across C1 prevented from being raised above its predetermined critical value.

(2) A point is reached in *every cycle* where the voltage across the tube falls below the "extinguishing" value. This ensures that voltage control takes place in the time of each cycle and mitigates against any tendency for the device to "hunt."

(3) The device does not depend for its operation upon a careful balance of component values and valve characteristics ; provided the valve will pass sufficient current with zero grid volts and practically none with the grid at 50 volts negative, no other characteristics matter. (In actual practice a large variety of triode valves can be tried in the circuit for comparison without disclosing any marked variation in the stabilising feature.)

Actually, the curve of Fig. 6 does not obtain because the current which flows in the neon tube circuit and the cutting-off of the anode-cathode current by the negative grid when the neon strikes and passes current modifies the curves of Fig. 6 (a) and hence Fig. 6(b). The actual resulting curve is shown in Fig. 7, which, of course, also represents the voltage on the grid of the valve throughout one cycle. Fig. 8 shows by comparison the effects resulting from changes in AC input. It will be noticed that the higher the input rises the sooner the neon strikes, whilst the peak voltage of the condenser C1 rises only very slightly.

The necessity for the potentiometer arises from the fact that the striking voltage of the most satisfactory type of neon

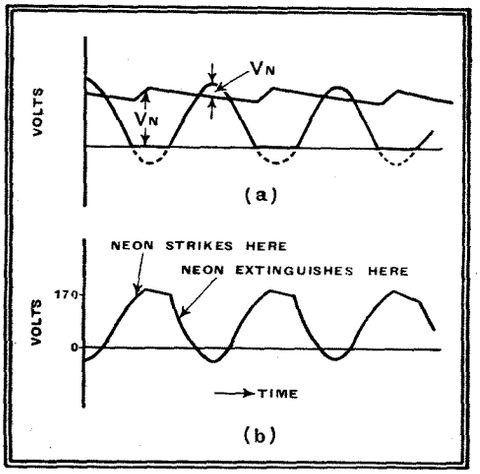



Fig. 6. Diagram (a) shows the derivation of the neon voltage ; the resultant waveform is given in diagram (b).

tube is far less than the required voltage across C1 and also enables the output to be varied over a wide range at will.

In order that the valve in the stabiliser-rectifier shall have a long life it is fitted with a filament which is worked at from

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1/10th to 1/5th of its rated emission value. Also grid-to-cathode current is not allowed to rise above perfectly safe limits. The average value for the grid current is about 9 microamperes.

It is necessary to find a valve for use as "combined rectifier and stabiliser" from the range of valves already available, and the PX25, or equivalent, will be found to provide the necessary characteristics. In regard to the "neon tube," there are on the market, already available, neon tubes which have a striking voltage of approximately 170 volts, so that there is nothing

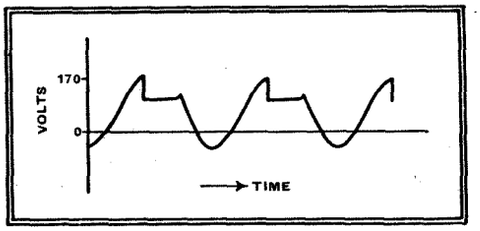



Fig. 7.—The actual waveform of the neon lamp voltage.

in the complete stabiliser which cannot be readily obtained by amateurs.

The complete unit is suitable for operation over prolonged periods, and a large number of these have been operating continuously for a number of months in positions where they are subject to vibration

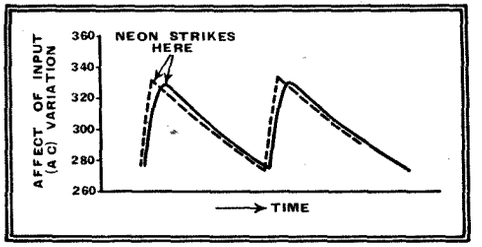



Fig. 8.—Effect of variation of input AC voltage on the striking point of the neon lamp. Full line represents low applied voltage; dotted line, high applied voltage.

of traffic and continual changes of temperature and atmospheric conditions generally. The results obtained have been extremely satisfactory, and it is felt by the authors that a device such as this, of proved merit, would be extremely useful for radio workers for feeding measuring instruments or timing devices, oscillators, and for many other purposes which rise to one's mind.

The arrangement described in this article is covered by British Patent No. 481597.

# Letters to the Editor

The Editor does not necessarily endorse the opinions of the correspondents

### *Indoor and Frame Aerials Compared*

IN your issue of August 18th I criticised the article "Indoor or Frame Aerial?" on the basis that Mr. Strafford's results referred to the effective height only and hence required a somewhat drastic correction if they were to be taken as a measure of the relative effectiveness of frame and indoor aerials for broadcast sets. This interpretation was based upon the wording of the article, but I have since heard from the author that a photograph of the apparatus, which would have clearly shown that the aerials were tuned, could not be satisfactorily reproduced as an illustration to his article.

However, his results still need some correction (which may be as large as 10 db. or so) before they are applied to the ordinary broadcast receiver, since the indoor aerial was connected direct to the top of his tuned circuit instead of to a tap or coupler as required in practice.

This makes the results somewhat uncertain; however, it seems probable that under some conditions (for example, where a good earth is available and no metal occurs in the building structure) signal strength from an indoor aerial may be at least as good as from a frame. M. V. C.

Cambridge.

### *Broadcast Frequency Tests*

I NOTICE with interest in a recent Editorial a request that the B.B.C. should again transmit calibration tones from an oscillator. With this I heartily concur, but I do not approve of your suggestion that the output be varied to compensate for the loudness contour of the average human ear at some specified loudness level.

At first sight, this variation seems desirable for the benefit of those who have to judge loudness by ear alone. In practice, however, I think that the advantage is of doubtful value, and outbalanced by the disadvantages from other points of view. It is extremely difficult to judge relative loudness of tones of widely differing frequency, and those who have to do this work make a practice of comparing the test tone with some reference tone, and adjusting until both seem equally loud. The setting of the controls then gives the information subject to the personal error of the observer.

In the case envisaged, however, i.e., just listening, with no reference tone and no turning of knobs, even the approximate accuracy of the expert cannot be approached, and the error due to the departure of the "average ear" from linearity ceases to be a major factor.

Other considerations which count against the use of specific weighting networks are that there is no standard sound intensity level at which people listen, and very few listeners know how much their ears differ from average. Their ears are liable to be nearer average than is possible in the case of some average statistics (e.g., in the average family there are 2½ children); even so, unless their ears have been calibrated and found average, any specific network might not apply. In fact, it is quite normal for the two ears to have different characteristics.

This request for calibration tones was revived by the recent organ tests in which the top notes were very feeble, or not heard at all by many people. In those cases where they were not heard at all it was probably due to cut off in the set or speaker; in the case of those who heard the notes feebly, it should be remembered that such notes in an organ are principally used to add harmonics to notes of lower pitch. Consequently, the voicing (adjustment of strength, which owing to the differences in the acoustics of various halls has to be done after installation) is such as to give the most pleasing audible result.

This involves a much smaller output from the highest-toned pipes than that required if an organ plus "mike" is to be used as a substitute for a constant output oscillator. It is therefore quite in order for these high notes to be relatively weaker.

Turning now to the disadvantages of the proposed weighting network, we have the following:—

(*a*) It complicates the information obtained in those cases where a suitable meter is available.

(*b*) Many amateurs can fit up a simple indicator capable of indicating gain or loss, but, as many of these may have square law operation, or be difficult to calibrate, a signal from the B.B.C., whose intensity varies with frequency, becomes very unsuitable.

(*c*) Probably the most important, if a weighting network is used, some tones including the low bass will be modulated much more deeply than those around 2,000 cycles. Owing to such deep modulation, many sets will introduce easily heard harmonics much higher up the scale. Even though the apparatus may be incapable of reproducing the fundamental, the unskilled listener will hear the harmonics loudly, and draw conclusions which are totally incorrect.

There has been very much discussion on the question of "cooking" the response curve to suit the volume level of reproduction. Our experience in this connection is, however, that, while cooking can be perfectly justifiable so long as radio is looked upon as being a nice noise requiring seasoning to suit the individual's taste, the only cooking which is necessary when really life-like reproduction is aimed at is that required to compensate for deficiencies in the response curve of the chain as a whole.

### "Perfection" Defined

So much depends upon the definition of "perfect." Some people might consider anything imperfect which does not convert chamber music into jazz, or vice versa.

My definition would make "perfect" correspond to the word "true" (not necessarily the same as the most pleasant), i.e., a raucous motor horn should sound raucous and not mellow if perfectly reproduced.

As far as I can see, so long as the chain is limited to a single channel and the rooms are live, the nearest approach to true reproduction which is possible is that which gives the listener the impression that, instead of listening to a loud speaker, he is listening through an opening corresponding to the loud speaker direct to the performance going on in an adjoining studio. It is my experience that this is only obtainable when the chain as a whole is as level as possible.

The only kind of variation from constancy of calibrated tones which would be permissible in such tests is a variation which corresponds faithfully to such factors, e.g., transmitter cut-off, etc., as are normally present

**Letters to the Editor—**

during B.B.C. transmissions. The experimenter who then gets a level response from his instrument will know that his receiver compensates exactly for such variations as are inherent in the transmissions.

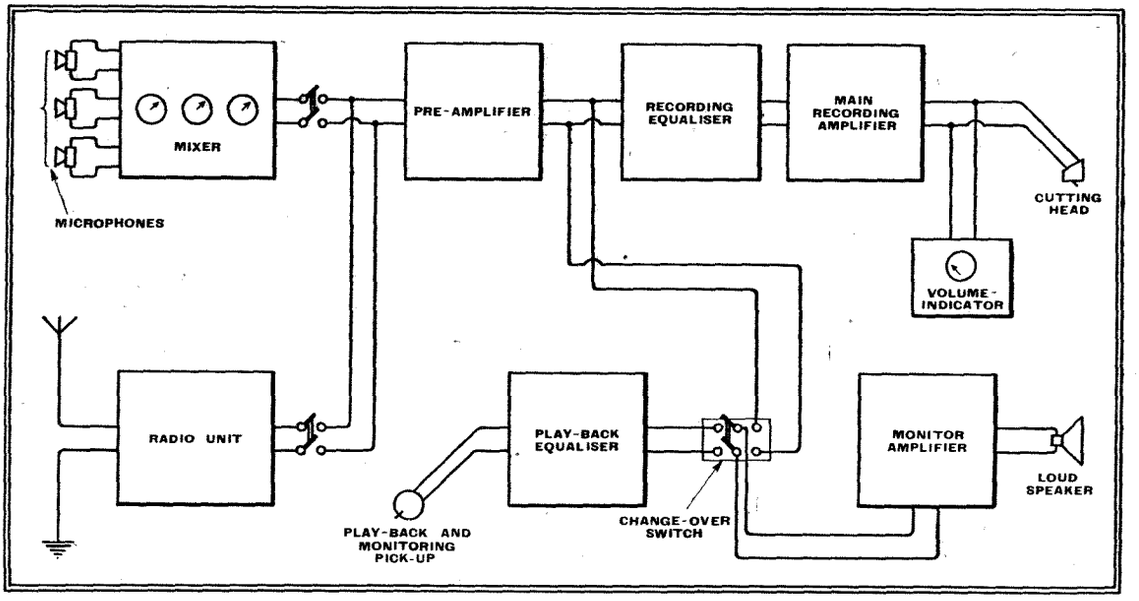
In such a case it would, however, be very desirable for the B.B.C. to publish full details in order that the results obtained can be checked against the known calibration of the receiver concerned. Even if the request for calibration tones cannot be granted, exact information regarding response curves from sound wave in the studio to aerial in each of the several transmitters would be most valuable. This should include P.O. lines where these are normally in circuit. Reverberation curves of some of the studios have already been published, but, even so, it would be useful to repeat this information. P. G. A. H. VOIGT.

London, S.E.26.

## Home Recording

THE six articles by Humfrey Andrewes on "Home Recording" (*The Wireless World*, July 14th to August 18th) are a useful contribution to the literature of this subject. In fact, the only fault of the series was its title, "Home Recording," which is a misnomer. Admittedly, the recording methods and equipment described in Mr. Andrewes' articles could be, and doubtless are, used at "home," but surely this is a very restricted conception of the applications of such technique and apparatus? Why not substitute "Direct Recording," "Instantaneous Recording" or "Amateur Sound Recording"? Or, better still, "Sound Recording on Direct Play-back Blanks"?

Since no diagram of a lay-out for a complete recording unit was included in Mr. Andrewes' articles, it occurred to me that readers might be interested in a set-up (see accompanying diagram) that I have found very successful in practice; it is based on a scheme suggested by Mr. C. J. Lebel, the well-known American recording consultant. The advantages of the lay-out are, *inter alia*, (1) it permits play-back monitoring, i.e., the pick-up is placed on the record a few grooves behind the cutting head, so that one can detect distortion, surface noise, etc., during the actual cutting, and (2) it enables one to make a direct check on the incoming quality and, by flicking the change-over switch, to make an instantaneous comparison with the sound quality as recorded and then reproduced via the same monitoring equipment.




Recommended lay-out and connections for complete recording unit (see accompanying letter).

DONALD W. ALDOUS.

Ilford, Essex.

## Long-distance Ghost Images

I WAS interested in the subject of ghost images, discussed in "Television Topics" in your issue of September 15th.

So far as I am aware, attention has not been drawn to another very peculiar form of ghost image which frequently manifests itself on receivers employed in this locality. I refer to the appearance of strong reflections producing images displaced by approximately two-thirds of the picture's width and *entirely reversed in phase*, i.e., the ghost image is negative, the line sync. pulses band being white.

Personally, I cannot think of a reasonable explanation for this phenomenon, and I shall be very interested to hear if a similar effect has been observed by others and whether a tenable explanation for the phenomenon can be suggested.

In any event, the above may be of interest for two reasons: (1) Perhaps some inference as to the path of propagation of the reflection may be derived from the fact that for 90 per cent. of the time when reflections are experienced the ghost image is displaced by two-thirds of the picture width. (2) The reversal in phase of the reflection is not constant. Without any change in position of the ghost image the phase will suddenly reverse, after some few seconds returning to a normal positive ghost image. S. WEST.

Beccles, Suffolk.

# NEWS FROM THE CLUBS

### Eastbourne and District Radio Society

**Headquarters:** The Science Room, Cavendish Senior School, Eastbourne.
**Hon. Sec.:** Mr. T. G. R. Dowsett, 48, Grove Road, Eastbourne.

At a recent Committee Meeting it was decided to go back to monthly meetings, commencing on November 7th.

At the meeting on October 4th experiments were conducted with the 5-metre transmitter, and it was shown how it could be quickly adapted for battery operation. It was decided to fix an aerial to the transmitter at the Society's headquarters.

### Southend and District Radio and Scientific Society

**Headquarters:** The Priory School of Dancing, 152a, High Street, Southend.
**Hon. Sec.:** Mr. J. M. S. Watson, 23, Eastwood Boulevard, Westcliff-on-Sea.

The opening meeting of the new season was held on October 7th. Arrangements have been made for meetings to be held at a more central place than hitherto. In future they will be held at the Priory School of Dancing, 152a, High Street, Southend. The entrance is situated in the approach from the High Street to the Strand Cinema.

### Ilford and District Radio Society

**Headquarters:** St. Albans Church Room, Albert Road, Ilford.
**Meetings:** Thursdays at 8 p.m.
**Hon. Sec.:** Mr. C. E. Largen, 44, Trelawney Road, Barkingside, Ilford.

The Society has maintained continuous activity throughout the summer months. The transmitter, which is in course of erection, has been allotted the call-sign, G3QU. A library section has been formed. On October 6th a junk sale was held.

The Society publishes a very well-edited monthly Bulletin, the annual subscription to which is 1s.

### Wirral Amateur Transmitting and Short Wave Club

**Headquarters:** Beechcroft Settlement, Whetstone Lane, Birkenhead.
**Meetings:** Last Wednesday evening in each month.
**Hon. Sec.:** Mr. J. R. Williamson, 13, Harrow Grove, Bromborough.

At the September 28th meeting Mr. R. Cumberlidge demonstrated a low-powered wireless transmitter consisting of an 89 tri-tet capacity coupled to a 46 PA. The Club is hoping to arrange a visit to Liverpool Head Post Office to see the telegraph instruments and picture-sending apparatus.

### Tonyrefail and District Radio Society

**Headquarters,** 81, Pritchard Street, Tonyrefail.
**Meetings:** Wednesdays at 7 p.m.
**Hon. Sec.:** Mr. E. Powell, 44, Pritchard Street, Tonyrefail.

A very successful field-day was held on September 11th. Four members now have call-signs. Morse practice is held at every meeting.

### Radio, Physical and Television Society

**Headquarters:** 72a, North End Road, London, W.14.
**Meetings:** Fridays at 8.15 p.m.
**Hon. Sec.:** Mr. C. W. Edmans, 72a, North End Road, London, W.14.

The annual general meeting took place on September 30th. It was decided that the Society would, with one or two minor alterations, be run on the same lines as hitherto. The annual subscription is 7s. 6d. The first lecture of the season will be on October 21st.

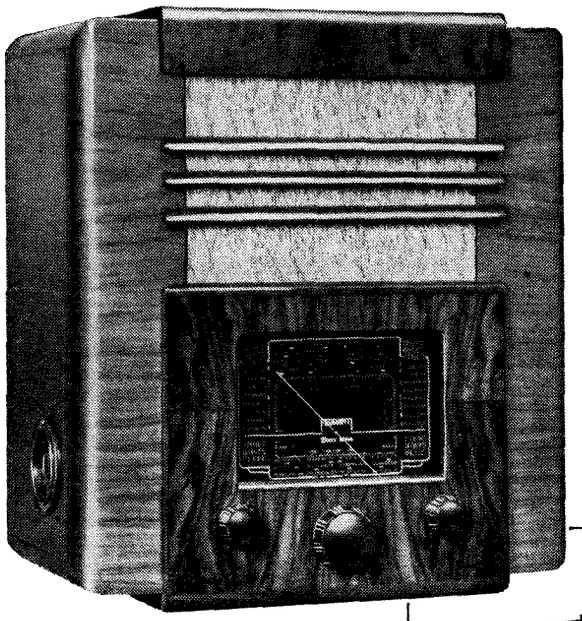
### Isle of Man Radio Society

**Headquarters:** 6, Stanley Place, Victoria Road, Douglas.
**Hon. Sec.:** Mr. W. Lawson, 13, Second Avenue, School Road, Onchan.

The following programme has been arranged by the Society which has been recently formed:—

**October 20th.**—A dinner at "Sherwood House," Douglas.
**October 27th.**—A visit to the Douglas Corporation Power Station.

There are at present twenty-five members in the Society, but it is hoped that this number will be greatly augmented before very long. Among the members are three licensed transmitters, and the Club is making application for its own transmitting licence.



# Ferranti MODEL 513AM

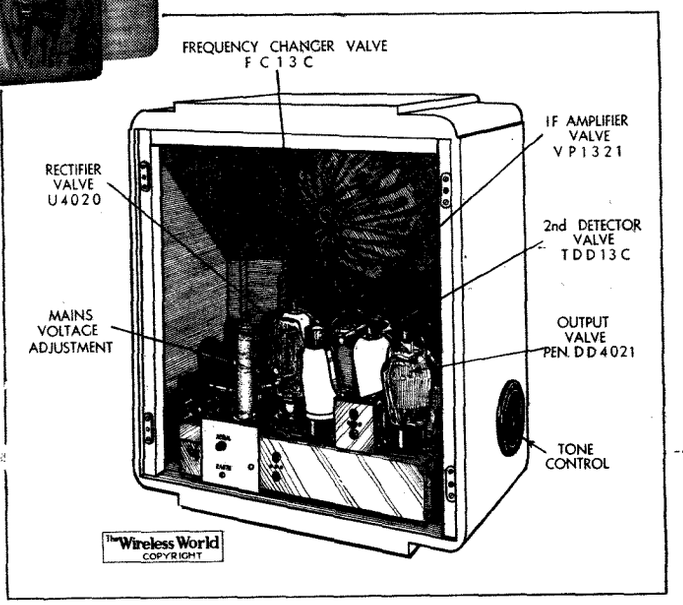
## AN AC/DC SUPERHET WITH A GOOD ALL-ROUND PERFORMANCE

NOT only is this receiver universal in the sense that it can be connected to either DC or AC supply mains, but also in the efficient manner with which it covers all the various requirements of the broadcast listener. It is compact and businesslike in appearance, has a large easily read tuning scale, is simple to operate and brings in distant stations with the same crispness that characterises the quality of speech and music from the local station.

Plenty of amplification is provided by the four-valve superheterodyne circuit which employs in the output stage an efficient pentode forming part of a double-diode-pentode valve. The diodes in this valve are not used and additional amplification is provided by the triode section of the second detector and AVC valve. Variable tone control is applied in the anode circuit of this triode stage and a further degree of fixed correction is made in the output circuit of the pentode.

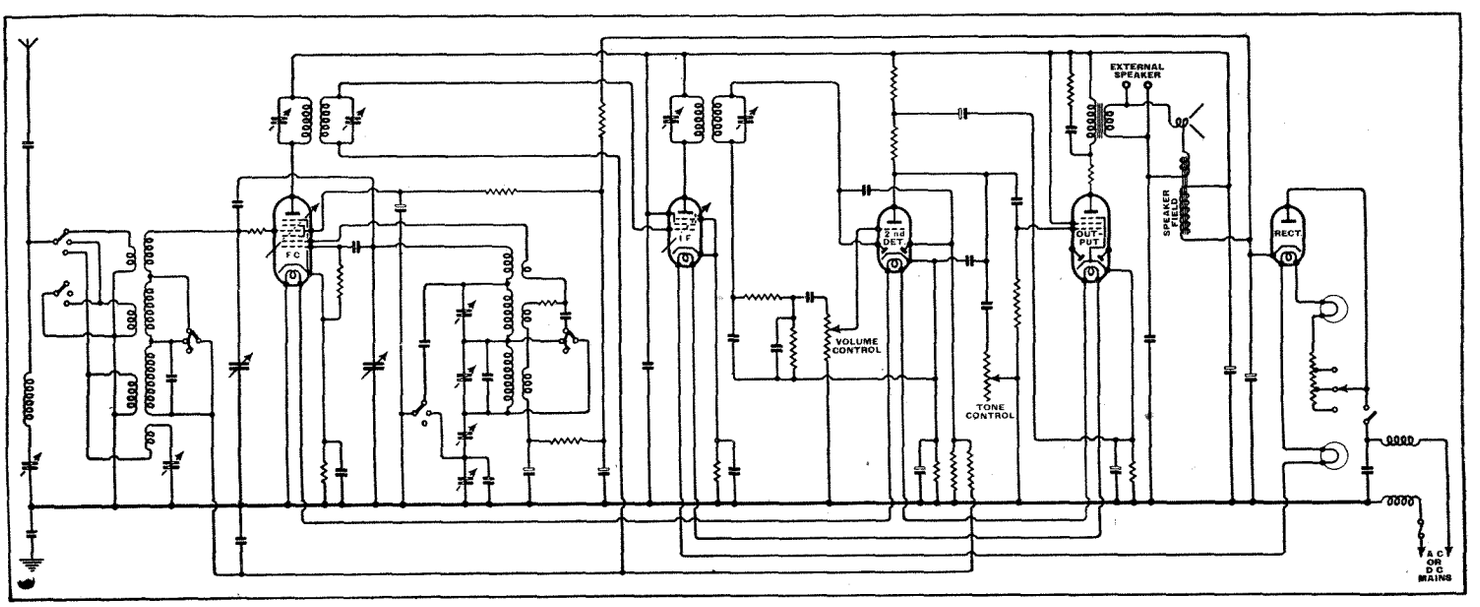
The variable tone control is fitted flush in a recess at the left-hand side of the cabinet and gives a range of control with a comfortable margin to cover all the demands which the different conditions of reception may make upon it. More than sufficient high-note response is available to correct for the effects of selectivity in the tuned circuits, particularly on long waves, and this excess can be usefully employed in heightening the effect of programme matter which calls for a bright and crisp response. On the other hand, the loud speaker has a good fundamental bass response which comes into its own when the high-note response is reduced and volume increased. By this means an excellent balance is achieved on orchestral transmissions, and the volume is well up to the equivalent of 3 watts, which is the undistorted rating of the output valve.

The AVC system is efficient, and if, as a result of connecting the rectifier to the output IF transformer secondary, some sideband accentuation is apparent, this is useful in the absence of a tuning indicator in estimating when a station is exactly in tune. A frequency of 450 kc/s has been adopted for the intermediate frequency and the stage




Special mains plugs and sockets are arranged automatically to disconnect the receiver when the back is removed.

**FEATURES. *Waveranges.*—** *(1) 16.5 - 51 metres. (2) 200 - 560 metres. (3) 1,000 - 2,000 metres.* ***Circuit.*—** *Octode frequency changer—var.mu pentode IF amplifier—double-diode-triode 2nd. det. AVC and 1st AF ampl.—pentode output valve. Half-wave valve rectifier.* **Controls.** — *(1) Tuning. (2) Volume and on-off switch. (3) Waverange. (4) Tone.* **Price.**—*13½ guineas. (12 guineas in moulded bakelite cabinet without tone control.)* **Makers.**—*Ferranti Ltd., Moston, Manchester.*




Complete circuit diagram. The output stage makes use of the high-magnification pentode section of a double-diode-pentode valve.

**Ferranti Model 513AM**

gives the set sufficient selectivity to separate the Deutschlandsender from Radio Paris and Droitwich with some help from the tone control, and reduces interference from Brookmans Park to a negligible level 1½ channels on either side of its normal setting at a distance of 15 miles.

A very lively performance as regards range is given on all three wavebands, the medium-wave band being particularly good with a wide choice of Continental stations in daylight at full loud speaker strength. Self-generated whistles are rare and the only one of any importance noticed during the test was caused apparently by overloading of the frequency-changer on the local station, for it disappeared when a shorter aerial was tried. The frequency-changer is an octode with a neutralising capacity between the oscillator and input grids.

Signal-to-noise ratio on short waves is good and the amplification is uniform over the full range of 16.5 to 51 metres. Although there is no barretter regulating lamp, the oscillator is quite stable and American transmissions were held throughout the duration of their news bulletins. Microphonic feed-back was entirely absent.

Hum on both AC and DC mains was negligible and the RF chokes which are included in both the mains leads successfully suppress all types of mains-borne interference.

The chassis is constructed on economical lines with unscreened IF transformers mounted above and below the base. A large rectangular glass tuning dial with double pointer is edgewise illuminated and engraved with station names in colours corresponding with dots which indicate the setting of the waverange switch. The single-ratio slow motion drive has been chosen to give an effective compromise between the requirements of the three waveranges.

From every angle this receiver acquits itself well and no single item of the performance has been neglected or allowed to overshadow the rest. It is a set which can be safely recommended without prior knowledge of the special preferences, if any, of the prospective user.

# *Random Radiations*

*By "DIALLIST"*

## A Mysterious Business

DID you, I wonder, sit up with your receiving set on that historic night when the results of the Munich conference were awaited by the whole world? If so, you may have had much the same rather puzzling experience as came my way. Not very long after midnight Radio Paris closed down, the announcer saying that the news had come through that there would be no official statement issued during the night. The B.B.C., however, kept going and we felt pretty sure that something would eventually come through. I kept on switching over to American stations on the short waves to see whether they had anything to say about events in Europe. At 2 o'clock one of them—W2XE, I think it was, though I have mislaid the notes that I scribbled down at the time—asked all listeners to tune their sets very carefully, saying that a momentous announcement would be made exactly at 2.15. Precisely at that time the whole text of the Munich agreement was read.

## Still Waiting

Turning back to the home stations, I found them still announcing at intervals that there was no news yet. This went on and on, and not until 3 a.m. was the agreement read verbatim. It seems rather surprising that America should have had the news a whole hour before the text was read here and that their stations should have been able to give the exact wording of the agreement to listeners no less than 45 minutes before it reached the hands of the announcer at the B.B.C. microphone. One doesn't know how the delay happened; there must, of course, have been some good reason for it. Anyhow, when the news did come through it was such a vast relief that all who heard it must have felt that it was well worth waiting for.

## Excellent Service

Really, I hardly know how I'd have got on without my wireless set during those critical days. Living, as I do, in the country, where we don't see any evening papers until hours after they have appeared in London, I couldn't possibly have kept track of the march of affairs if I hadn't been able to receive not only the home stations, but also those in other countries. As it was, one had up-to-the-minute information all the time; and what's more, it was accurate information. The B.B.C. gave us noble service and the American stations were always there to give us different points of view.

## A Novel Aerial

WHEN I'd moved into my new abode I found myself for the moment without an aerial. That was an impossible state of affairs, so something had to be done about it right quickly. My first makeshift was a strand of No. 30 DCC wire slung diagonally across the drawing-room with the help of small nails tapped into the picture rail. That answered quite well, but, on looking round, I saw something that might do still better. There's a big rectangular bay window and running round the three sides of this is a white enamelled iron curtain rod about an inch in diameter. The total length of the rod is about 18ft. The ends are tapped for those knob things that prevent the curtain rings from sliding off. Inspection showed that the tapping was 0 BA. It was the work of a moment to fish out a piece of 0 BA studding and to rig up a terminal. Then a wire was run from this to the set and I found that reception was really excellent. It's so good, in fact, that I shall certainly keep that curtain-rod aerial for the family receiving set, and others may find the tip useful. I am putting up a nice high outdoor aerial to serve my own workroom. As the house stands not much under 600 feet above sea-level and the aerial will be 40 feet high, and quite unscreened, I am hoping for some pretty good results.

## Peace on the Short Waves

IT'S difficult to tell you what a joy it is to be able to conduct short-wave reception without constant interference from motor car ignition systems. Except at certain times when tradesmen's delivery vans are busy, I don't think that more than two or three cars an hour go past the house. And I don't get any of the buses or heavy lorries, which troubled me so much at my previous abode. The result is gloriously peaceful reception of even faint transmissions on the short waves. One thing that I shall be able to test for myself now is the difference in intensity of the radiation from cars going up hill and down hill, which has been the subject of some discussion of late in these notes and in the Correspondence columns of *The Wireless World*. I am on a very steep hill and as soon as the opportunity presents itself I'll get some friend with a good noisy ignition system to his car to make some trial runs up and down past the house.

## The Chinese Stations

YOU remember the derelict wireless stations discovered by Sir Eric Teichman in Mongolia and Chinese Turkestan which I mentioned a week or two ago? A reader very kindly sends me a copy of an extract from the *Sphere* of December 24th, 1921, describing the erection of these stations. They were to serve a vast tract of land, largely desert, through which runs the Central Asian highway, a caravan route thousands of years old. It was this highway that was used to transport over distances between 700 and 3,000 miles the tons upon tons of material required for the erection of the three 25-kilowatt transmitters with their 300-foot lattice steel masts. Bullocks and camels were employed for the transport and the material had to be put up in packages, none of which weighed more than 350 lb. No small item of the baggage was the money to pay for the labour of erection. The silver dollar was the only coin which was acceptable everywhere, and hundredweights of these had to be carried.

## The Vodka Arc

Roughly 300 tons of material were required for each of the three stations and this was carried by 2,000 camels and 800 bullock carts. The first caravan accomplished its journey to Urga comparatively speedily, but the second took five months to cover the 1,600 miles to Urumchi. The third must have needed the best part of a year to get to Kashgar, for it hadn't arrived when the *Sphere* article was written. The plant consisted of high-speed oil engines driving DC dynamos, and the transmission system used was the Marconi version of the Poulsen Arc, which was one of the earliest CW methods of wireless telegraphy transmission, if not the earliest of all. The article states that the arc was developed inside a water-cooled chamber in a gas produced from alcohol: "As ordinary alcohol is rather scarce in this part of the world, vodka has on occasion

# Broadcast Programmes

FEATURES OF THE WEEK

THURSDAY, OCTOBER 13th.

Nat., 7.0, Geraldo and his Concert Orchestra. 7.45, "Blackbirds"—excerpts from Lew Leslie's coloured show. 8.30, "The Mediterranean," talk by F. A. Voigt. 10.20, "Mainly about Manhattan," talk from America by Alistair Cooke.

Reg., 6.0, Scrapbook for 1923. 7.30, "The Gate"—a sound picture of the daily work at Southampton Docks. 8.15 and 9.30, The Royal Philharmonic Society's Concert.

*Abroad.*

Beromunster, 7.20, Mozart Concert, conducted by Denzler.

FRIDAY, OCTOBER 14th.

Nat., 6.25, "The English Family Robinson." 7.15, Famous Music Halls, No. 1—The South London Palace. 8.15, Carroll Gibbons and his Orchestra. 9.25, "Advance in the Air"—talk. 10.45, French talk by Yvette Guilbert.

Reg., 7.30, Beethoven Violin Sonatas, played by Adolph Busch. 8.10, Discussion on Private Enterprise and Public Ownership in Coal. 9.0, Reginald Foort conducts another tour round the B.B.C. Theatre Organ. 9.20, "Mouzel Feast," a Cornish concert.

*Abroad.*

Milan Group, 8.0, "Il Biricchino di Parigi," operetta (Montanaro).

SATURDAY, OCTOBER 15th.

Nat., 2.30, Commentaries on National Covered Courts Tennis Championship of Great Britain, and Brooklands Mountain Motor Racing Championship. 7.30, In Town To-night. 8.0, Sing-Song, including Leonard Henry and Florence Oldham. 9.25, American Commentary.

Reg., 6.0, Five Hours Back—Relay from America. 6.30, B.B.C. Organ Recital—I, by Günther Ramin. 8.30, The Microphone at Large. 9.0, Farewell Flight over Blackpool.

*Abroad.*

Lille, Toulouse PTT, 8.30, Acts 3 and 4, "Boris Godunov," opera (Mussorgsky).

Sottens, 8.30, "The Last Waltz," operetta (Oscar Straus).

SUNDAY, OCTOBER 16th.

Nat., 11.45, Charlie Kunz. 5.0, "The Hour Glass" a morality by W. B. Yeats. 5.30, Chopin Recital by Moiseiwitsch. 9.5, Terence de Marney in the first instalment of "The Cloister and the Hearth."

Reg., 4.0, Turner Layton in Songs at the Piano. 6.30, Sunday Evening Concert, conducted by Sir Adrian Boult. 9.5, Recital by Peter Dawson (Bass-baritone). 9.35, The Life of Walter Barnes, fisherman of Brixham, Devon.

*Abroad.*

Bucharest, 7.15, Viennese Operetta Music.

Strasbourg, 9.0, "Les Cloches de Corneville," operetta (Planquette).

MONDAY, OCTOBER 17th.

Nat., 6.40, Puzzle Corner. 7.0, Beatrice Lillie in "Monday Night at Seven." 8.10, Musical Biography of Franz Liszt—Victor Hely-Hutchinson and Egon Petri. 9.25, World Affairs.

Reg., 8.15, "Murder on the Second Floor"—a play by Frank Vosper. 9.15, "I Remember"—with the B.B.C. Midland Singers and Orchestra.

*Abroad.*

Konigsberg, 7.10, Beethoven's Ninth Symphony.

Leipzig, 7.10, Symphony Concert, with Walter Ludwig, tenor, and Patzac, 'cello.

TUESDAY, OCTOBER 18th.

Nat., 6.45, Eddie Carroll and his Orchestra. 8.0, "For You, Madame." A magazine programme for women. 8.30, "Legionnaires—Chantez!" 9.25, "It Occurs to Me," talk by Lord Elton.

Reg., 7.30, Tommy Matthews and his Concert Orchestra. 8.30, The Under Twenty Club. 9.0, A Jack Payne Production. 9.40, "The Ugly Duckling," a reading.

*Abroad.*

Kalundborg, 8.55, Acts III and IV, "Aida," opera (Verdi) from the Royal Theatre.

WEDNESDAY OCTOBER 19th.

Nat., 6.20, Whitehall Tour: The Admiralty. 7.45, The World Goes By. 8.15 and 9.40, The First Symphony Concert of the Season 1938–9 from the Queen's Hall.

Reg., 6.35, Medvedeff's Balalaika Orchestra. 8.0, Snooker Commentary: Davis *v.* Newman. 8.20, Band Waggon. 9.20, Variety from Coventry.

*Abroad.*

Strasbourg, 8.30, Mozart Festival Concert.

Brussels I, 8.45, Jazz Composers—I, George Gershwin.

been used." The writer goes on to say: "The Urga station is the most up-to-date wireless station in China, being fitted with the latest Marconi amplifiers, an improvement upon Professor Fleming's 2-electrode valve."

## Television Forging Ahead

FROM all that I hear, television is making big strides after the good start that it got at the Wireless Exhibition. In my own little town two television aerials have gone up during the last fortnight and several others are to follow. I don't doubt that there'll be quite a good crop of them visible before Christmas. Personally, I am inclined to ascribe television's growing popularity in no small part to the very successful outside broadcasts which are being made. The Prime Minister's arrival at Heston on his triumphal return from Germany is a good example of the kind of outside broadcast that makes everyone wish that he had a televisor. As you will remember, I have always maintained that the future of the entertainment side of television would lie very largely in outside broadcasts. I still strongly believe this, for one of the public's keenest desires is for news. The news bulletins of ordinary sound broadcasting have probably a larger audience than any other part of the programmes, and the pictured news made possible by television must be an enormous attraction.

## Televised News Reels

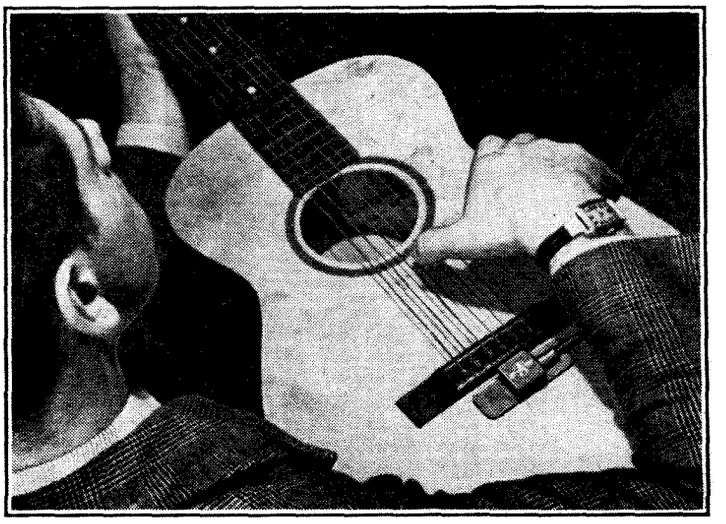
The present news reels are all very well in their way, but they are not exclusive to television. I am convinced that in the not so distant future there will be up-to-the-minute television news reels sent out at least once a day by the television transmitters. In my mind's eye I see the OB vans attending all interesting events within the range of the coaxial cable or the radio link of the Alexandra Palace and televising things as they happen. I see, also, ciné recording vans working in other parts of the country and making films which will be rushed by rail or road or air to the News Editor's room at Alexandra Palace and such other transmitting stations as there may be. Here, television's own news reels will be made up and transmitted at definite times to viewers. I don't think the idea far-fetched, and it seems to me that it's workable, though the greatest care would have to be taken that no injury would be done to the newspapers, which are one of our greatest national assets.

## The Popular Microphone

EVER since there were such things as wireless sets those who use them have been filled with the desire to fit them with microphones so that they could use the AF stages and the loud speaker to amplify their own talking or singing or playing. Some years ago I remember counting the best part of a dozen different kinds of small "mikes" in the window of one wireless shop a little before Christmas-time. Though most of these little fellows in those days weren't up to much (unless you were prepared to pay a pretty stiff price for them), people bought them fast enough and didn't seem to mind a bit of distortion so long as they worked in some kind of way. Nowadays you can buy quite a useful miniature "mike" at a remarkably low price, and I can see experts vying with one another to obtain the best possible quality in "home broadcasting." There's a great deal of fun to be got out of a small "mike," quite apart from its interest for experimental purposes.

## A New Fault

MY local paper loves to unearth a striking bit of wireless news for the delectation of its readers. The other week it came out with a fire scare headline: "HOUSE SET ON FIRE BY WIRELESS SET." The guilty receiving set, I learnt, had burst into flames and only by the greatest good fortune had it been possible to save the house from being reduced to ashes. But what had caused the wireless set to behave in this unusual and highly reprehensible manner? Ah! you may well ask. The instrument, it was explained, had developed a shortening (*sic*) within it and omission to have this seen to had caused all the trouble. Never neglect a shortening, or you may find your home the subject of big headlines in *your* local paper.



**CONTACT MICROPHONE. This American microphone is designed for direct attachment to stringed instruments such as guitars, violins, mandolins, etc. It was recently used in a broadcast by the Philadelphia Symphony Orchestra to reinforce a mandolin solo. Another application is to assist musicians who have become deaf to hear their own playing through headphones.**

# Television Topics

DEVELOPMENT in television has led to the appreciation of effects which are often overlooked in broadcasting equipment. Although they may be of less importance than in television apparatus, they are by no means always negligible. Two effects which are somewhat inter-related are

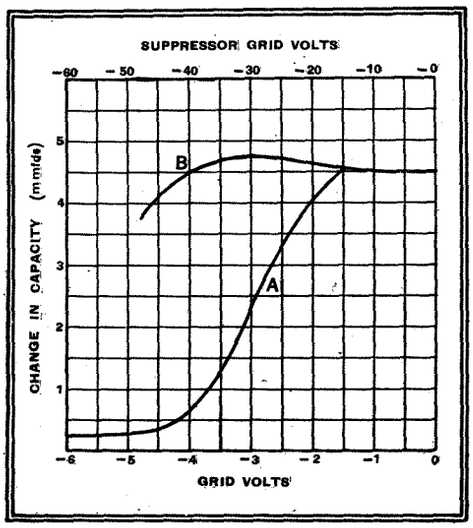



**Fig. 1. Curve A shows the change of input capacity of the SP41 as the grid bias is varied, while curve B shows the effect of biasing the suppressor grid. The grid bias is then 0.06 of the suppressor bias.**

variations in the input resistance and capacity of valves with changes in the grid bias.

It is well known that every valve has an input capacity which is made up of the capacity between the grid and cathode, screen-grid, and other electrodes. The capacity varies with different valves and usually lies between 5 $\mu\mu$F and 15 $\mu\mu$F. When a valve is used as an RF or IF amplifier this capacity forms a part of the total capacity tuning the intervalve coupling. In ordinary broadcast receivers the capacity is not of great importance, so long as it is constant in value, for it merely restricts the tuning range somewhat. With television equipment, however, the capacity becomes very important because it is a large proportion of the total tuning capacity. Any reduction in the capacity makes higher amplification possible for the same band width.

Now it is obvious that if for any reason the input capacity changes, the tuning will change, too, and this will alter the shape of the resonance curve and may cause distortion. It is found in practice that the input capacity does change with a variation in the grid bias, and so we have the unfortunate result that varying the gain affects the resonance curve.

The magnitude of the effect is best shown by means of an example. The Mazda SP41 has an input capacity of 11 $\mu\mu$F with the cathode cold. When the cathode is hot but with the valve biased beyond current cut-off the capacity increases to 11.25 $\mu\mu$F. As the bias is reduced the anode and screen currents rise, and, due to space charge effects, the input capacity rises also until at the normal operating point it reaches 15.5 $\mu\mu$F. The curve of Fig. 1, which is due to the valve makers, shows the change in input capacity from the cold value plotted against grid bias.

If we normally operate at −1.5 volts bias the capacity is 4.5 $\mu\mu$F greater than the cold value, and if for gain control we increase the bias to −3.5 volts the capacity is 1.25 $\mu\mu$F greater than the cold value. The change of capacity with bias is thus 3.25 $\mu\mu$F in this case.

The effect of this change depends on the total circuit capacity. In a television IF amplifier this might well be 30 $\mu\mu$F with a tuned anode-type coupling. The gain control will vary the capacity from 30 $\mu\mu$F to 26.75 $\mu\mu$F, so that the resonance frequency increases proportionately to the square root of 30/26.75, or about 1.062 − 1. If the resonance frequency is 10 Mc/s at full gain it will be 10.62 Mc/s at low gain, so that the tuning of the circuit has shifted by 620 kc/s.

This is quite important. Fortunately, it can be overcome to a very large extent by controlling gain not merely by biasing the control grid but by biasing the control and suppressor grids together in the correct degree. The bias applied to the control

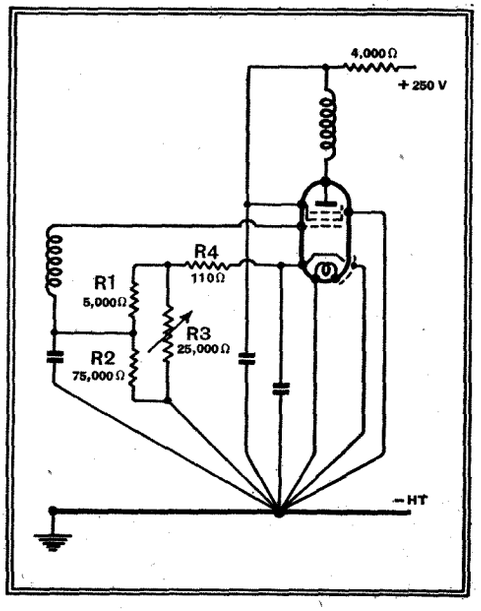



**Fig. 2. One way of obtaining control and suppressor grid bias in the correct ratio is illustrated here. It is important to adopt the point connection shown for certain leads when working at high frequencies.**

grid should be about one-seventeenth of that applied to the suppressor. The results obtained when the ratio of grid to suppressor volts is 0.06 are shown by curve

## VALVE INPUT CAPACITY AND RESISTANCE

B of Fig. 1. At the normal bias the capacity is 4.55 $\mu\mu$F, and at −3.5 volts it is 4.7 $\mu\mu$F—a change of only 0.15 $\mu\mu$F instead of 3.25 $\mu\mu$F. This is a big improvement, and as it can be obtained quite simply it is well worth while to do so.

The arrangement recommended by the valve makers is shown in Fig. 2. An initial bias resistance R4 of 110 ohms is provided, and additional bias is obtained

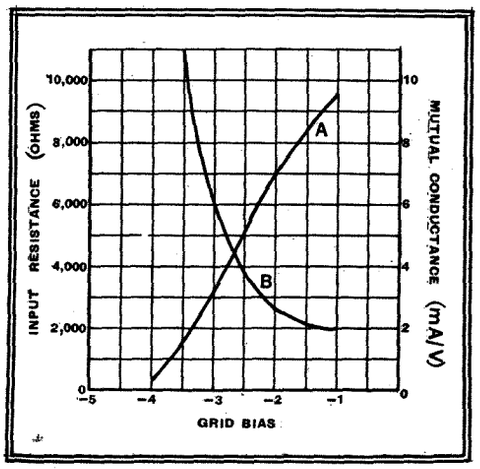



**Fig. 3. Curve A gives the mutual conductance and curve B the input resistance at 45 Mc/s of the SP41.**

with the aid of the 25,000-ohm variable resistance R3. The suppressor bias is the full voltage drop across R3 and R4. The grid is connected through its input circuit to a tapping on a potentiometer across R3; this potentiometer comprises the resistances R1 and R2. The grid bias is thus equal to the voltage drop across R4 plus R1/(R1 + R2) times the voltage drop across R3.

### Method of Wiring

With the arrangement shown, the grid bias is about one-seventeenth of the suppressor bias, and an input capacity change very close to that of curve B of Fig. 1 is secured. For a change of gain in the ratio of 8 to 1, the input capacity change is some ± 0.25 $\mu\mu$F.

It will be noted that in Fig. 2 the earth return leads of the valve are shown as being made to one *point* only. This is important when working at high frequencies, and if the point connection is not adhered to, the operation will be seriously affected. The important leads are metallising, suppressor, and screen, anode, and cathode by-pass condenser connections. At high frequencies the impedance of even a short lead is appreciable, and if the point connection is not adopted serious coupling

**Television Topics—**

between input and output circuits is likely.

In addition to the input capacity the input resistance is very important at ultra-high frequencies. The input resistance is due in part to electron transit time effects, but it is also dependent on the impedance in the cathode lead of the valve. The important part of the cathode impedance, because it is not under the control of the user, is the impedance of the lead from the base pin to the cathode itself inside the valve. In general, valves which are constructed to have a short internal cathode lead have a higher input resistance than usual. Of course, impedance in the external cathode lead has an adverse effect, but this can be reduced to a low value by careful design.

With the SP41 operated at −1.5 volts grid bias the input resistance at 45 Mc/s is only slightly over 2,000 ohms! In view of the mutual conductance of 8.5 mA/V, this is rather higher than the average. As the bias is increased the resistance rises to about 11,000 ohms at −3.5 volts. Now a resistance of 2,000 ohms is of the right order for damping the tuned circuits in the RF stage of a television receiver, but when the valve is biased back to reduce the gain the resistance rises and the damping becomes insufficient. At the same time, the input capacity changes and mistunes the circuits. The effect of varying the gain control is thus quite marked on picture quality.

### Constant Input Resistance

Fortunately, the bias arrangement of Fig. 2 which gives a substantially constant input capacity also maintains the input resistance nearly constant. By the adoption of this circuit, therefore, both drawbacks are overcome.

The input resistance varies roughly in inverse proportion to the operating frequency, and will consequently be too high to have much effect at intermediate frequency. In general, it is only at frequencies higher than 20 Mc/s that input resistance becomes important.

Curves showing the variation of mutual conductance (A) and input resistance (B) at 45 Mc/s are given in Fig. 3 for the SP41 with 200 volts screen potential. In a television RF amplifier the requirements of band-width limit the dynamic resistance of the tuned circuit which can be used, and under average conditions it is of the order of 2,000 ohms. The dynamic resistance of the tuned circuit alone is usually higher than this, and the extra damping is provided by the input resistance of the valve. For other purposes we are not limited by band-width, and we usually want to make the effective dynamic resistance as high as we can. With a good circuit the stage gain will then be limited by the mutual conductance and input resistance of the valve.

It can be seen from Fig. 3 that the resistance goes up as the mutual conductance goes down. Consequently we should expect to find an optimum value of grid bias which gives maximum gain. The product of mutual conductance and input resistance gives the maximum gain obtainable from one stage of a multi-stage amplifier using the same valves in all stages and with tuned anode couplings of dynamic resistance high compared with the input resistance.

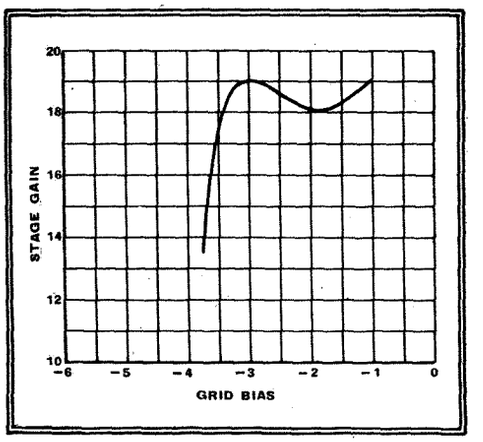



**Fig. 4. As explained in the text the maximum possible gain at 45 Mc/s tends to vary in the way shown here with alteration in grid bias. This is important for USW reception in general, but not necessarily for television.**

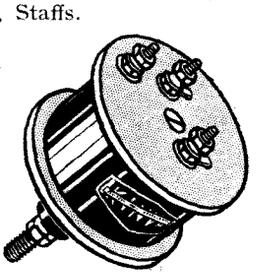
This product is shown in Fig. 4. It is of no interest to the television enthusiast, but is extremely interesting to the ultra-short-wave amateur. The gain is almost the same at biases of −1 volt and −3 volts, and is appreciably lower around the normal minimum bias of −1.5 volts. It is clear that the best bias is −3 volts, for the possible gain is highest, and as the input resistance is higher than with a lower bias the tuned circuits will be sharper. Furthermore, the current consumption will be lower.

This particular valve is not necessarily one that would be picked for general USW use, but it exhibits tendencies found with all valves. In practice it is quite noticeable that reducing grid bias beyond a certain point brings about no increase in gain, but a reduction in selectivity.

---

## Kinva Tone-Control Choke

IN the tone-control circuit of *The Wireless World* Communication Receiver a tapped choke is used for producing a rising characteristic. A component designed for this has been produced by Postlethwaite Bros., of Church Hill, Kinva, Staffs.



**Kinva tone-control choke for "The Wireless World" Communication Receiver.**

It is a slab type air-core choke with an inductance of 1.3 H. and is tapped at 0.5 H. The overall diameter is 2⅛ in. and the component is entirely suitable for use in the Communication Receiver. It is priced at 7s.

# Television Programmes

**An hour's special film transmission intended for demonstration purposes will be given from 11 a.m. to 12 noon each week-day.**

| Vision | Sound |
|---|---|
| 45 Mc/s | 41.5 Mc/s |

THURSDAY, OCTOBER 13th.

**3,** Cabaret, including Charles Harrison. **3.20,** Gaumont-British News. **3.30,** 181st edition of Picture Page.

**9,** The Motor Show. O.B. from Earls Court of some of the 1939 exhibits. **9.20,** The Lecuona Cuban Boys. **9.40,** British Movietonews. **9.50,** 182nd edition of Picture Page. **10.20,** News.

FRIDAY, OCTOBER 14th.

**3,** Marcella Salzer. **3.15,** British Movietonews. **3.25,** Demonstration of Ballroom Dancing. **3.40,** Cartoon Film. **3.45,** "In a Train to Exeter"; adapted from the short story by J. Geoffrey Stewart.

**9,** The Chester Hale Girls from the Dorchester Hotel. **9.15,** O.B. from the Motor Show. **9.30,** Derek Oldham with the B.B.C. Television Orchestra. **9.45,** Gaumont-British News. **9.55,** Punch and Judy Show. **10.10,** Cartoon Film. **10.15,** Music Makers. **10.25,** News.

SATURDAY, OCTOBER 15th.

**3,** C. H. Middleton. **3.15,** Cartoon Film. **3.20,** Junior General Knowledge Bee: Boys v. Girls. **3.35,** Gaumont-British News. **3.45,** "The Three Bears," a short ballet to music by Eric Coates.

**9,** Cabaret, including Charles Heslop. **9.30,** British Movietonews. **9.40,** Darts: Islington v. Lambeth. **9.50,** "Six-thirty Collection"—film. **10.5,** "Strauss-Tanze," ballet with choreography by Joy Newton. **10.20,** News.

SUNDAY, OCTOBER 16th.

**8.50,** News. **9.5,** "The Piper," an opera by Herbert Ferrers based on Browning's poem, "The Pied Piper of Hamelin"; cast includes Roy Henderson and Olive Dyer. **9.50-10,** "Symphony in the Tyrol"—film.

MONDAY, OCTOBER 17th.

**3-4.30,** "Many Waters," a play by Monckton Hoffe.

**9,** Eric Wild and his Band. **9.20,** British Movietonews. **9.30,** Marcella Salzer. **9.45,** Cartoon Film. **9.50,** "In a Train to Exeter" (as on Friday at 3.45 p.m.). **10.5** News.

TUESDAY, OCTOBER 18th.

**3,** Green Fingers for Greenhorns—A gardening talk by Reginald Arkell. **3.10,** Starlight. **3.20,** British Movietonews. **3.30,** "Storm over Wicklow," comedy by Mary Manning.

**9,** "Many Waters" (as on Monday at 3 p.m.). **10.30,** News.

WEDNESDAY, OCTOBER 19th.

**2.30,** O.B. from North Weald Aerodrome. Viewers will see some of the daily routine at a R.A.F. Aerodrome and war 'planes on the ground and in the air. **3.15-4,** "The Piper," (as on Sunday at 9.5 p.m.).

**9,** "The Emperor's New Clothes," a Hans Andersen story. **9.10,** Cartoon Film. **9.15,** How to bring last year's clothes up to date. **9.30,** British Movietonews. **9.40,** Sixth edition of Re-View. **10.5,** News.

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## BOOK RECEIVED

THE transmitting amateur will undoubtedly be interested in the Raytheon Handbook of Amateur Tube Uses. It is a 65-page booklet giving detailed information on Raytheon transmitting valves. Operating conditions are listed as well as the characteristic curves. In addition much useful general information on circuit design is given.

The booklet is obtainable in this country from Messrs. Leonard Heys, of Faraday House, Henry Street, Blackpool, at the price of 4s., post free.

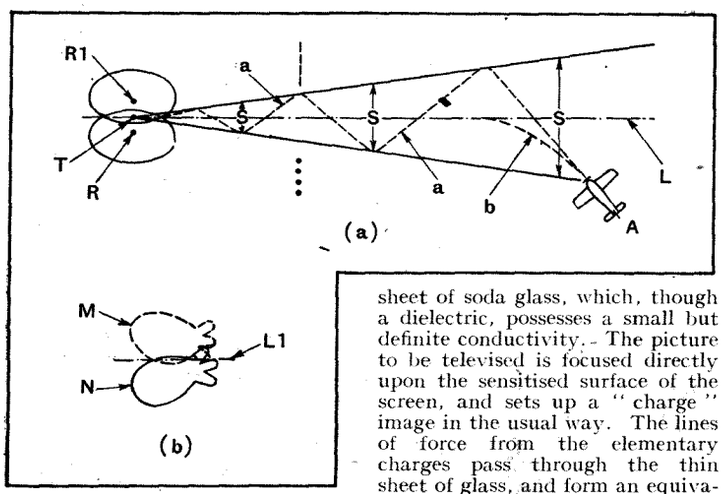
# Recent Inventions

***Brief Descriptions of the more interesting radio devices and improvements issued as patents will be included in this section***

## RADIO NAVIGATION

IN one well-known method of guiding an aeroplane to its destination the radiation from a short-wave transmitter T (diagram (a), is alternately deflected from side to side by two reflecting aerials R, R1, so as to produce two diverging beams which overlap along the sector marked S. One beam is keyed with "dash" signals, and the other with "dots" which are heard separately outside the limits of the sector S, but merge into a single continuous note inside it. The course of an aeroplane A flying along the sector can be represented by the zig-zag line *a*, the whole of which lies within the limits of the continuous-note region. But the shortest course would be along the middle or guiding line marked L.

The latter path can be followed, according to the invention, by replacing the usual single dipole aerial by two dipoles which are mounted on opposite wings of the craft. The directional response of each aerial is, owing to local reflection effects, then represented by the overlapping curves M, N in (b), and by switching the two aerials over, in alternation, the effect of a local or "receiver" guiding-line L1 is superposed on the transmitted guiding line L so as to increase the accuracy of steering.




**Landing beacon with a superposed guiding line in the centre of the sector.**

*Telefunken Ges. für Drahtlose Telegraphie m.b.h. Convention date (Germany) November 14th, 1936. No. 487302.*

o o o o

## TELEVISION TRANSMITTERS

IN a television transmitter of the Iconoscope type there is a tendency for the picture to be "blurred" if the light falling on the mosaic-cell electrode is allowed to dwell there long enough for a slight "shift" of the image to occur during the period of exposure.

This type of distortion can, of course, be remedied by "interlacing" the scanning lines. An alternative method, according to the invention, is deliberately to shorten the period during which the incident light can reach the mosaic screen by interposing a Kerr cell, or equivalent "shutter" device, between the image to be transmitted and the mosaic screen. The opening and closing of the shutter is then controlled by impulses derived from the usual synchronising device used for scanning.

*Radio-Akt. D. S. Loewe. Convention date (Germany), December 12th, 1935. No. 486896.*

o o o o

A "MOSAIC" screen is formed by depositing a layer of photosensitive particles on to a thin sheet of soda glass, which, though a dielectric, possesses a small but definite conductivity. The picture to be televised is focused directly upon the sensitised surface of the screen, and sets up a "charge" image in the usual way. The lines of force from the elementary charges pass through the thin sheet of glass, and form an equivalent electric image on the rear or uncoated surface of the screen; this directly faces the "gun" of the cathode-ray tube in which the screen is mounted.

Placed in close proximity to the uncoated side of the screen is a grid or collecting-ring which, under the action of the scanning stream, develops the signalling currents. One advantage of the arrangement is that the mosaic screen is set at right-angles both to the light from the picture, and to the scanning stream, instead of being inclined to both, as is more usual.

*F. A. Lindemann. Application date December 28th, 1936. No. 487940.*

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## STABILISING FREQUENCY

IT is well known that temperature variations tend to shift the frequency of circuits, such as those used in short-wave transmitters, and the circuit elements are therefore sometimes housed in a closed chamber, which is thermostatically controlled. To reduce expense it has been suggested, as an alternative, to surround the chamber with heat-insulating material so that the inside temperature can only vary slowly. This also helps to make the chamber more easily accessible for adjustment purposes, but it is found that temperature differences still tend to arise, and persist, between the different circuit components. A condenser, for instance, owing to its relatively high heat conductance, assumes the inside temperature more quickly than an inductance coil, and so varies the generated frequency.

It is now further proposed to sheath the tuning condenser with a ceramic material which serves to retard the penetration of heat, and so keeps its temperature exactly "in step" with that of the inductance. Alternatively, both circuit elements are placed in separate receptacles, each being sheathed with a heat-insulator which is suitably "graded" for the purpose in view.

*C. Lorenz Akt. Convention date (Germany), October 27th, 1936. No. 488076*

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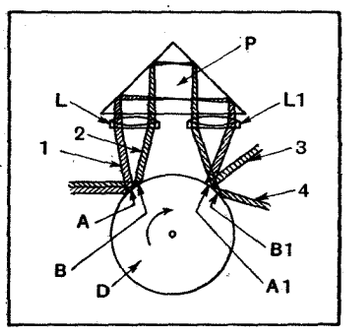
## MECHANICAL SCANNING

IN a rotating mirror drum, the angular deviation or "scanning angle" imparted to the incident beam of light is determined by the number and setting of the individual mirror elements. The object of the invention is to increase this angle beyond that normally obtained from a given number of elements, in cases where the scanning beam is returned more than once to the drum.

As shown in the Figure, light reaching the points A, B on the periphery of the drum D is diverged as shown at 1, 2, and after passing through a lens L, prism P, and lens L1, comes back to the drum at the points A1, B1. The final angle of divergence, shown at 3, 4, will be double the original angle 1, 2 if the focal length of the lens L is equal to that of the lens L1. The arrangement can also be used to secure the same divergence from a given size of scanning drum rotated at a lower speed than would otherwise be necessary.




**Increasing the angular deviation of incident beams of light.**

*Scophony, Ltd., and H. W. Lee. Application date November 13th, 1936. No. 487318.*

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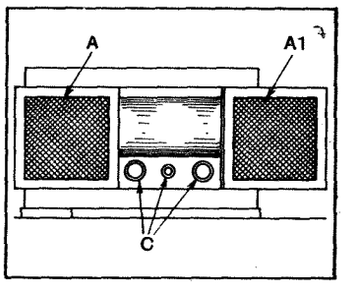
## WIRELESS CABINETS

THE cabinet is fitted with a sliding panel A1, which can be moved to expose the controls C for tuning the set to a desired station, and then moved back into contact with the similar fixed panel A and locked in that position. Both panels A and A1 are made permeable to sound, so that they can be arranged in front of the loud-speaker opening. When closed, the cabinet presents the appearance of a chest with a double door, and forms an inconspicuous piece of furniture. The arrangement is designed to prevent any unauthorised tampering with the tuning controls, particularly in the case of hotel and other public installations.




**Sound-permeable sliding doors for receiver cabinets.**

*Telefunken Ges. für Drahtlose Telegraphie m.b.h. Convention date (Germany) November 3rd, 1936. No. 487125.*

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## VALVE DESIGN

IN a valve containing auxiliary electrodes, such as screening and accelerating grids, it is desirable to reduce to a minimum the current absorbed by them from the main electron stream since, in general, it represents so much lost energy. For this purpose it has already been proposed to align the "turns" of the screening grid with those of the control grid in the path of the electron stream, but it is then found that if the arrangement is to secure the desired result, the "spacing" between the two grids must be kept small. The interelectrode capacity then becomes unduly large, and the sensitivity of the valve falls off accordingly.

To overcome the difficulty, the inventor provides a valve having three concentrically arranged spiral grids, the one nearest to the cathode being the control grid and the one farthest away the screening grid, with a third or intermediate grid which is maintained at cathode potential. This arrangement is stated to cut down screen-grid current without increasing the interelectrode capacity.

*C. S. Bull. Application date September 18th, 1936. No. 487768.*

**The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each**

# The Wireless World

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*As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.*


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# *EDITORIAL COMMENT*

## Amateur Transmitters

### *An "L" Licence?*

SEVERAL transmitters, apparently old hands who tend to forget that everything must have a beginning, have expressed disapproval of last week's Editorial, in which we pleaded for a relaxation of the Post Office attitude in granting transmitting licences. One critic paints a gloomy picture of the chaotic state of the ether likely to result from the letting loose of "hundreds of unqualified amateur operators."

Now we did not suggest, or even imply, that the present standard of operating qualification should be lowered ; on the contrary, we should not be greatly perturbed if a move were made to impose a higher standard of operating ability. All that we did was to urge that the farcical (as it has now become) condition that applicants for licences should have serious experimental work in view should be abandoned, and in the national interest amateur transmitting should be actively encouraged by the authorities.

### *Precautions Necessary*

We are fully alive to the fact that an increased number of transmitters might well result in serious interference and that this interference might even extend, if proper precautions were not taken, to bands occupied by commercial and other services. An untrained and inexperienced operator can unwittingly do a great deal of mischief, but, to minimise such a risk, we suggest that the authorities might well consider the issuing of a probationary licence, in some respects similar to the well-known "L" motor-driver's licence. The parallel cannot be carried too far ; for instance, it would hardly be reasonable to require the budding amateur to operate his stations during the probationary period, only when a fully licensed amateur was present. It seems reasonable enough, however, to ban telephony transmissions for, say, the first year, during which period only CW telegraphy, with its narrower band width and, consequently, lower interference-creating potentialities, should be used.

Again, before allowing the new licensee to operate his own station, he might quite reasonably be required to produce proof that he had operated a station for a given number of hours under the supervision of a qualified operator. This is a matter in which the various wireless clubs could be of the greatest assistance to would-be transmitters.

### *Encourage the Amateur*

The AA (Artificial Aerial) licence granted to those who at present do not attain the required standard does not enable the amateur to obtain any experience in the operation of a transmitter under practical conditions in congested wavebands and, therefore, fails to meet the case.

We must not here be too deeply concerned with the detail of regulations which the Post Office should require of those entrusted with the right to transmit, because we do not want to lose sight of the object in view, which is to obtain recognition of the principle that the training of wireless operators is an urgent matter—that the younger a start is made the more proficient the operator will become and that training is a slow business before first-class operating ability can be acquired.

Concede the principle that amateurs should be actively encouraged and the detail of essential control will easily follow.

# Car Aerials EFFECTIVENESS OF THE VARIOUS TYPES

By F. R. W. STRAFFORD
(Research Dept., Belling and Lee, Ltd.)

*AS compared with the average domestic installation, the aerial system of a car is almost ludicrously ineffective, strict limitations as to its length and height being imposed by practical and aesthetic considerations. All the more reason, as the author points out, why the properties of car aerials should be carefully studied in order that the maximum amount of signal energy may be extracted from an inherently inefficient arrangement.*

IF it were not for the inherent directional properties of the frame aerial, there is little doubt that a carefully designed receiver employing this aerial system would provide a far better signal pick-up than the open type of aerial at present in use for motor car installations. It is the sharp minima of signal which would occur every time the frame was square to the direction of the station which eliminates it without further consideration.

In view of the known inefficiency of car aerials, it is necessary to study their properties carefully so that compromises in design may be effected whereby the signal pick-up may be increased without sacrificing the general appearance of the car.

Some interesting measurements were taken in the early stages of this problem, and consisted of the measurement of signal pick-up on a short vertical collector placed first inside the car, and secondly at the same height from the ground with the car removed completely.

The car was a 10 h.p. saloon of popular make, with a metal body, so that it formed a partial screen, the windows being responsible for the imperfection thereof.

The signal strength of London Regional fell to 1/100th of its former value when the apparatus was placed in the car. Opening the sunshine roof and all four doors reduced this value so that the ratio became 1/70th of the unscreened pick-up. These results indicate the general impracticability of designing any form of open aerial circuit system for use within the coachwork of the car, unless, of course, it is known that this is mainly of wood, a material that is seldom used nowadays for the average lower-priced car.

It is necessary, therefore, to place as much as possible of the aerial system external to the car itself, and the problem that immediately arises is that of choosing the correct position relative to the car framework.

We cannot make these decisions without a knowledge of the mechanism whereby such a badly screened and poorly elevated aerial works, and it is presupposed that the reader has already acquainted himself with the writer's earlier article on receiving aerials.* Summarising certain of the deductions made in this article, we may say that (a) a vertical aerial whose height $h$ is small compared with the wavelength of operation will produce between its base and earth a voltage of approximately $\frac{Eh}{2}$ where $E$ is the field strength of the vertically polarised wave. (b) It does not matter how tortuous the path taken from the base of an aerial to its tip, the voltage is for all practical purposes determined solely by the shortest distance between the extremities. (c) Adding a horizontal roof to such an aerial system does not increase the EMF generated in the aerial, but increases the current through it, hence the potential difference applied to the receiver input increases. (d) The earth lead constitutes part of the aerial system. (e) The presence of neighbouring earthed conductors will modify the electromagnetic field in the vicinity of the aerial system, and hence modify the resultant EMF developed in it. The usual effect is that of decreasing the EMF.

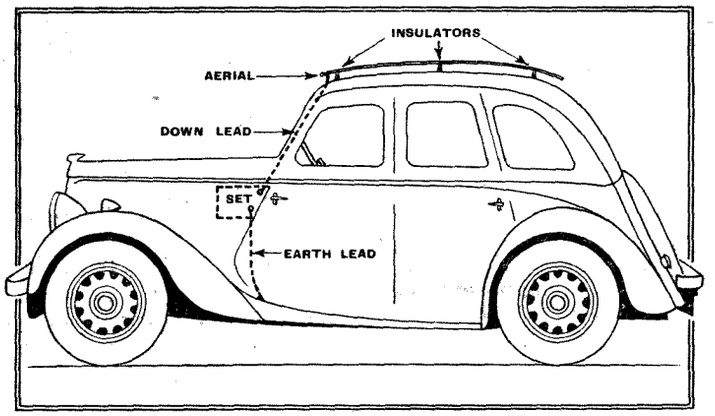


Fig. 1.—A typical aerial-earth system, with external aerial.

* Published in last week's issue.—ED.

It is very difficult to visualise processes occurring in three dimensions. Many problems in circuit engineering are readily visualised, but the effect of electromagnetic waves on aerial systems does not permit of such effortless investigation. In fact, the more one studies the problem the more does one realise the necessity for a profound mathematical appreciation of the fundamental laws of electricity and magnetism.

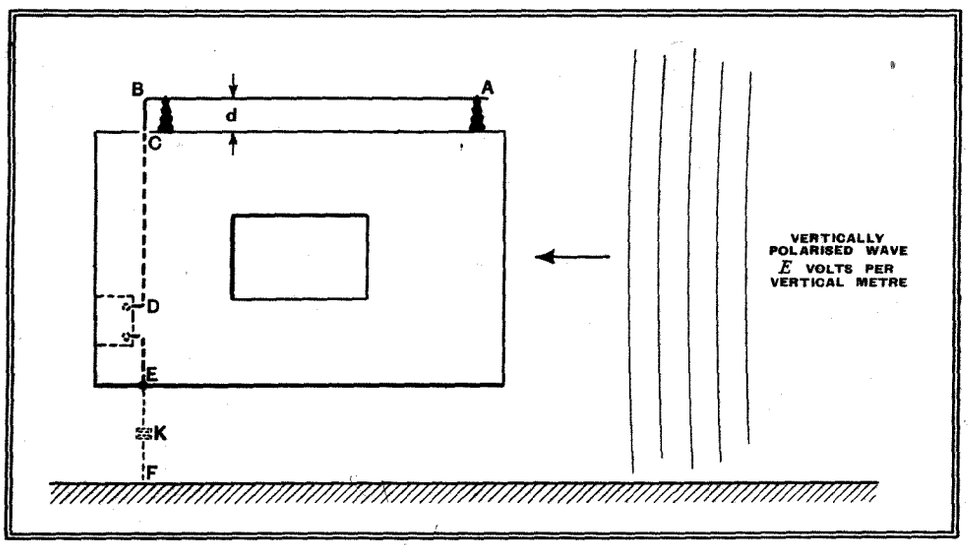


Fig. 2.—Not an Earls Court model, but, to the wireless man, strictly the electrical equivalent of Fig. 1. The car may be considered as a metal box, with apertures cut at each side to represent the windows.

## Simplifying the Problem

In an attempt to reveal to the average reader the mechanism whereby these small aerial systems work, it is quite obvious that the explanation will seem somewhat crude to the physicist, but he must remember the complexity of the problem and realise that such explanations as can be offered may at least help to dispel many common misconceptions.

Let us consider the problem generally of a typical aerial system wherein the major portion of it is erected in a horizontal position on the roof of the car, a down-

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lead being taken into the interior for the purpose of connection to the receiver. There will be a further lead from the receiver to a convenient portion of the chassis, but it must be borne in mind that the leads to the aerial and earth terminals on the receiver must often take an indirect path. A typical car aerial installation is depicted in Fig. 1.

This diagram must be simplified a little in order that the mechanism whereby the aerial system operates may be better described. The equivalent arrangement may therefore be depicted conveniently, as in Fig. 2, in which the car has been replaced by a metal box, and the capacity of the car to earth is represented by a fixed condenser K.

Now K does not play a very important part, since its capacity is of the order of 300 m-mfds. and its reactance over medium and long waves is therefore of moderate magnitude. The effect of earthing a car chassis is to produce a small increase of signal strength on long waves and a negligible increase on medium, with average receiver input impedances. For all practical purposes we may, therefore, forget K and consider that it short-circuited.

Consider the action of the system when placed in the path of a vertically polarised wave—that is, a wave whose electric intensity is vertical, and whose magnetic intensity is at right angles thereto and perpendicular to the paper on which the diagram is illustrated. Every free electron in every conductive particle in the system, including the car, oscillates upwards and downwards at a frequency corresponding to that of the transmitted wave. These movements of free electrons constitute electric alternating currents, and some of them will flow through the aerial system A, B, C, D, E, F, and hence through the receiver input impedance, thereby creating a signal input voltage across it.

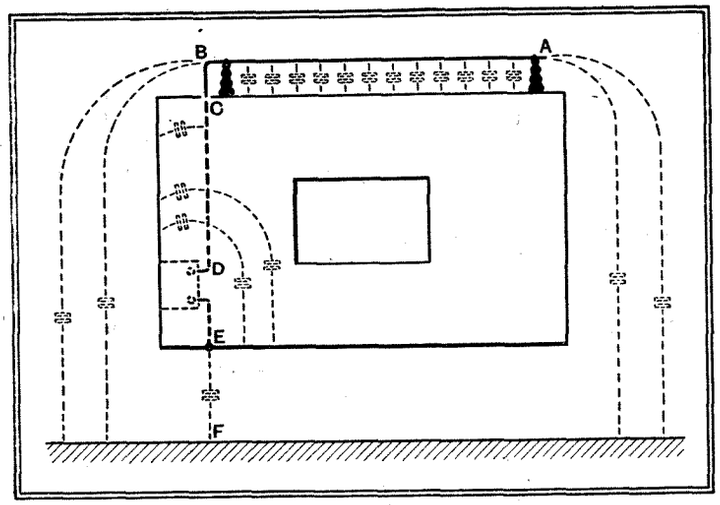



Fig. 3. The aerial system of Fig. 2, with the addition of condensers to represent capacity between the aerial, car body and earth.

Now currents cannot flow in any conductor unless the circuit is completed, but it must be borne in mind that while the point A is disconnected in the circuital sense it forms part of a rather bulky condenser. We must imagine our system to comprise an infinite number of little capacities joined in parallel; hence we may redraw Fig. 2 and show some of these condensers in Fig. 3.

Now between the roof of the vehicle and the horizontal portion A-B of the aerial a great concentration of capacity will obviously exist, and we illustrate this by placing a relatively large number of small capacities in parallel over this particular region. Let us call these little elements of capacity $C_{BC}$: that is, the capacity between B and C.

It is further obvious that fewer capacities will exist between A-B and ground F. By similar notation we will call these $C_{BF}$. Quite a large capacity exists between the downlead C, B and the interior of the car, and these capacities may be regarded as harmful, for reasons to be given later.

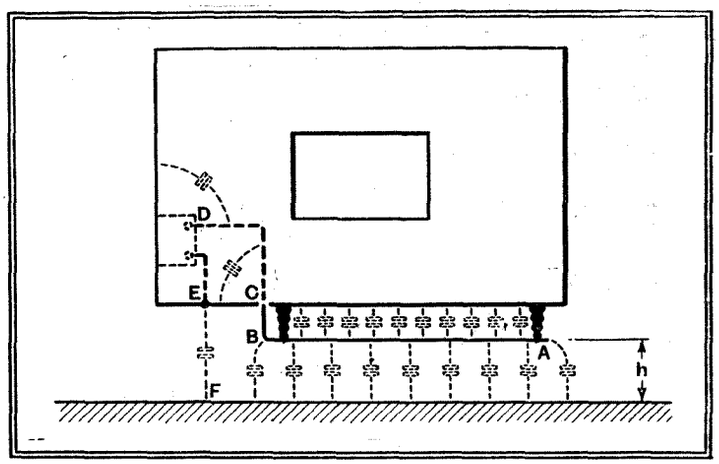



Fig. 4. An under-chassis aerial: there is a critical position between frame and earth for maximum signal pick-up.

The circuit of the aerial system is thus completed through a complex distribution of an infinite number of tiny capacities concentrated in the main between the horizontal portion of the aerial and the roof of the car, but nevertheless extending in lower magnitude to every other earthed point, even as far as the antipodes!

We now arrive at the most important point in the whole problem; in fact, we may say that the preliminaries are over and the study has commenced.

At a particular instant of time every capacity in the vicinity of the system will be carrying a current in the same direction, whether upwards or downwards. For the purpose of our study let us assume that it flows downwards to earth, and let us first consider the current which will flow round A, B, C, D, E, F, via the capacities $C_{BF}$ from A-B to ground.

These currents, by flowing through the receiver input impedance in their circuital path create part of the signal input. Now this contribution of current is due to a voltage generated in series with the circuit, and this voltage is equal to the product of the field strength and the height of the uppermost portion of the aerial to the ground. Thus if the impedance of the receiver input is Z ohms, and the impedance of all the little capacities $C_{BF}$ in parallel is Y ohms, the current through the circuit is $i_1 = \frac{Eh}{Z+Y_1}$.

Thus part of the contribution to the performance of a car aerial is the *height of the uppermost portion from the ground* and the *effective capacity to ground* of this uppermost portion.

Now a further contribution of current flows through all the little capacities from the horizontal portion of the aerial to the car roof, but the generating voltage which causes these currents is only between B and C, that is over the distance *d*. Thus $i_2 = \frac{Ed}{Z+Y_2}$ where $Y_2$ is the impedance of all the little capacities $C_{BC}$.

It may readily be seen, therefore, that our concentrated capacities from the horizontal portion of the aerial to the roof of the car can only help to increase the current for a much less efficient voltage source, so that the contribution of $i_1$ may be greater than that of $i_2$, even though there is a smaller distribution of capacity for the former.

## Reducing Signal Voltage

So far as the harmful capacities are concerned these are obviously acting in parallel with the receiver input impedance. Hence for a given current through the input they will reduce the effective voltage generated across it.

Now in the case of $i_2$, it is easy to see that if the capacity of the horizontal portion of the aerial system to the roof of the car is increased by adding more wires in parallel it can only increase the available voltage at the receiver in the limit to $E \times d$.

Raising the same horizontal portion a few inches will increase *d*, hence the signal voltage will increase *pro rata*. Furthermore, the raising of the horizontal portion, while not constituting a very large percentage increase of the total height of the uppermost portion to ground, will increase the number of little capacities to earth, and the contribution to $i_1$ is thereby increased.

Thus raising the horizontal portion of the aerial above the roof of the car in-

**Car Aerials—**

creases *i2* by virtue of increasing the available voltage in the system, whereas *i1* increases due to an increase in the distributed effective capacities to ground.

A strip of copper tape ½in. wide by 5ft. long was mounted on insulators ½in. from the metal roof of a saloon car, and the signal pick-up on both London Regional and Droitwich was measured by means of accurately calibrated and carefully screened apparatus. The strip was then mounted 2½in. above the roof of the car, and it was observed that the signal strength increased by some four times on medium wave, and five times on long. According to theory the value should be slightly in excess of the amount stated, but second-order effects have, of course, been neglected in the simplified explanation which has been given.

One thing is axiomatic, however. For a given height of the horizontal portion of the aerial system, this portion should be so positioned that its effective capacity to earth and not to the chassis of the car should be a maximum. For this reason a wire running round the edge of the roof of a car is very much more effective than the same amount of wire located over the centre of the roof.

It is often the practice to locate a suitable metal plate or series of wires under the chassis of a car to constitute an aerial system, and it is instructive to add this system to our study. Fig. 4 illustrates the equivalent arrangement, including the distribution of some of the infinite number of little capacities which are shared between the aerial system, the ground, and the chassis of the car.

An important difference in the mechanism whereby the signals are picked up occurs here as compared with the system on the roof of the car. The capacities between the aerial system and the chassis, in other words, those lying between A-B and the base of the car, are not responsible for any contributory current through the impedance of the receiver. The only contribution to the current through the receiver impedance is due to those capacities which exist between A-B and earth. The voltage generated in the system is equal to the field strength multiplied by the height *h*. In this case, therefore, the capacities existing between A-B and the chassis of the car itself may be added in parallel with those capacities existing from the aerial connecting lead to the interior of the car, and may be classed as harmful capacities.

The effect of lowering the horizontal portion of the aerial A-B towards the ground is to reduce the generated voltage in the aerial system, but it does not follow that the current through the receiver will fall off, because it must be remembered that the harmful capacities between the aerial system and chassis are now reduced. It is not difficult to see that there must be some position for the horizontal portion which gives the maximum signal pick-up, and the position depends upon the input impedance of the receiver itself. For a very high impedance the position is midway between the chassis and ground, but for low input impedance the position is nearer the chassis. In no circumstance does any improvement ensue if one passes the midway position towards ground.

A metal plate 4ft. long and 1ft. wide was fixed at a distance of 9in. below the main chassis framework, and the signal pick-up on Droitwich and London Regional was approximately 25 per cent. greater than that obtained by the 5ft. strip located 2½in. above the roof of the car.

This article would be incomplete without reference to short vertical rod aerials of which several types have made their appearance in this country.

The mechanism whereby the rod aerial operates is identical to that for the aerial erected on the roof, in that we must consider not only the capacities which exist from the rod itself to the chassis, but also those which exist from the rod to ground.

Tests were carried out on a rod which was located near the bonnet of the car about 1ft. forward of the windscreen. This rod protruded about 4ft. above the bonnet.

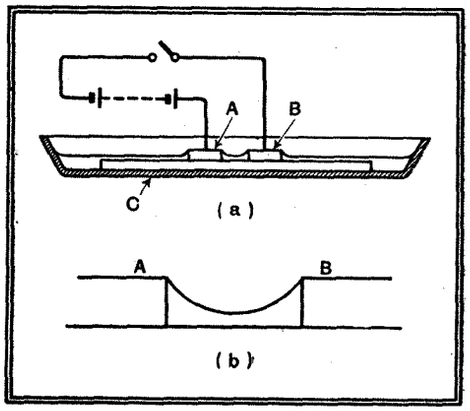
The signal pick-up on this system proved to be twice as good on London Regional as compared with the roof aerial, but very little different on the Droitwich wavelength. This increase in signal strength on medium waves, while very useful, is rather offset by the appearance of the aerial itself, and, summarising, it would appear that the underslung aerial, apart from its creditable performance, would be preferable because it is out of sight and in no way alters the general appearance of the car.

In conclusion it might be of interest to note the difference in signal pick-up between the best car aerial described here and an inverted "L" aerial 25ft. high employing a 60ft. horizontal span. On medium waves the maximum available signal voltage from the car aerial averaged 1/30th of that available from a standard aerial, and on long waves about 1/50th.

These figures alone indicate the skill which must be employed to design receivers of a compact form with sufficient sensitivity to compensate, even partially, for these enormous losses.

# Controlling Light by Surface Tension

ALL liquids behave as if they were separated from the surrounding air by a stretched membrane, the effect being known as surface tension. Among other things, surface tension tends to make water creep up the inside of a small "capillary" tube. Similarly, it "lifts" the line of contact which water makes with a plane sheet of glass slightly above the surrounding level




**A simple "light valve"; the focal length of the liquid "lens" is controlled by the applied potential difference.**

of the liquid. In certain cases the line of contact may be depressed below the general level of the liquid. It all depends upon the liquid and the particular substance with which it is in contact.

If two strips, A, B (see diagram), of copper or aluminium are laid side by side in a shallow glass vessel, C, containing ethyl acetate, the surface of the liquid will rise up along the two lines of contact so as to form a curved meniscus, as shown enlarged in (b). As the liquid and its container are both transparent, the curved surface of the former can be used as a lens to focus a ray of light passing through it.

It has been found (Patent No. 484482) that if a potential difference is applied across the two electrodes, from a battery or other source of EMF, the curvature of the "lens"—and therefore its focal length—varies with the applied voltage. In a particular example the spacing between the two electrodes is given as one-fiftieth of an inch, whilst the depth of the enclosed liquid is one-eighth of an inch. An emerging beam of light, measured two inches from the lens, was found to vary from a width of two inches for zero PD to a width of one-eighth of an inch with 500 volts across the electrodes. The current passed amounts to a few micro-amps only, so that the power consumption is negligible.

With a key or microphone in series with the battery, the arrangement can be used for signalling or "talking" along a beam of light. It can also be used for recording sounds on a cinema film by the variable-width or variable-density method, or it can be used as a "light valve" generally.

# Artificial Auroras

**POSSIBILITIES OF GENERATION BY RADIO WAVES**

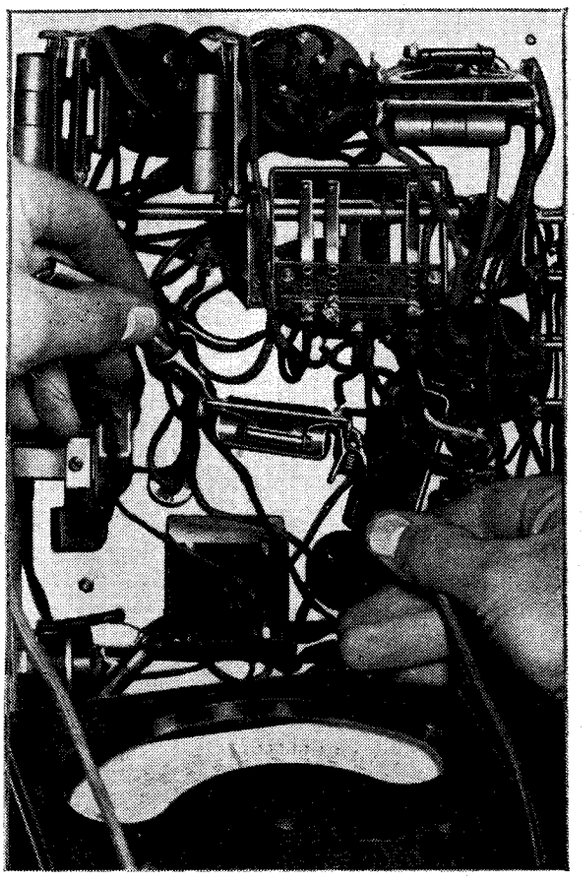
PROF. V. A. BAILEY, of the University of Sydney, in a letter to *Nature*, suggests that it should be possible to generate glow discharges in the region of the E layer by sending up a circularly polarised vertical beam at the "local gyro-frequency," i.e., the frequency of gyration of free electrons in the earth's magnetic field.

According to Prof. Bailey's calculations, a power of 500 kilowatts would be required, and the aerial system might consist of 800 horizontal half-wave aerials covering an area of 2 kilometres square and raised one quarter wavelength (about 50 metres) above ground. He suggests the 500 kW broadcasting stations at Cincinnati and Moscow as possible sites for the initial experiment, and concludes that with a power of 1 million kilowatts it would be possible to create enough illumination on a clear night to fulfil the minimum requirements for the lighting of roadways.

# Intermittent Faults

## SOME TYPICAL EXAMPLES AND HOW TO TRACE THEM

By "TRIMMER"



STRAIGHTFORWARD meter-testing methods, as usually applied to cases of continuous faults, are apt to break down with "intermittents," for one cannot always be sure of getting the right kind of meter at the right spot at the right time. The fact that a fault is intermittent, however, implies that conditions in the receiver must change when the fault comes on, and close observation of the details of the change may provide valuable clues.

Exact rules of procedure, suitable for every case that may arise, cannot be laid down; nevertheless, systematic methods of working are required if the difficulties of tracing intermittent faults are to be minimised.

The first move should always be to try to bring the occurrence of the fault symptoms under definite control, for if some way can be found to make the fault start and stop (under one's own control), it should not then be difficult to trace it.

In a large percentage of cases it will be found that mechanical disturbance of the part containing the fault will exercise some control on the fault symptoms. Valves with loose electrodes, bad welds, insulation leakages, and other defects that can cause intermittent trouble generally show definite indication of being faulty when they are subjected to vibration, so the simple test of tapping the valve bulbs, with the receiver in action, will often disclose the existence of a defective valve. A point not to be overlooked, however, is the fact that mains valves will sometimes show up as faulty only after they have become thoroughly hot.

With the receiver kept switched on, and tuned to a signal, all accessible components and wiring should be gone over with an insulated probe, and, within reason, this operation should not be of too gentle a nature. Some of the most common intermittent faults can be brought under control (and, therefore, tracked down) by probing. Loose connections and dry joints generally respond to such treatment and it will quite frequently be found that intermittently defective resistances and fixed condensers will "give the show away" when they are disturbed with a probe.

*DEFECTS that manifest themselves intermittently and for brief periods are obviously much more difficult to trace than complete breakdowns of insulation or continuity. The nature of intermittent faults in broadcast receivers is explained in this article and methods of locating them are described in detail.*

While going over the chassis the opportunity should be taken of making close inspection for certain types of assembly defects. Particularly should a good lookout be kept for any signs of likely short-circuits between components, or between a component and chassis, for in a congested chassis there may be decided possibilities in this direction. Any intermittent faults so produced are not faults that could be easily deduced from a study of the theoretical diagram of the receiver.

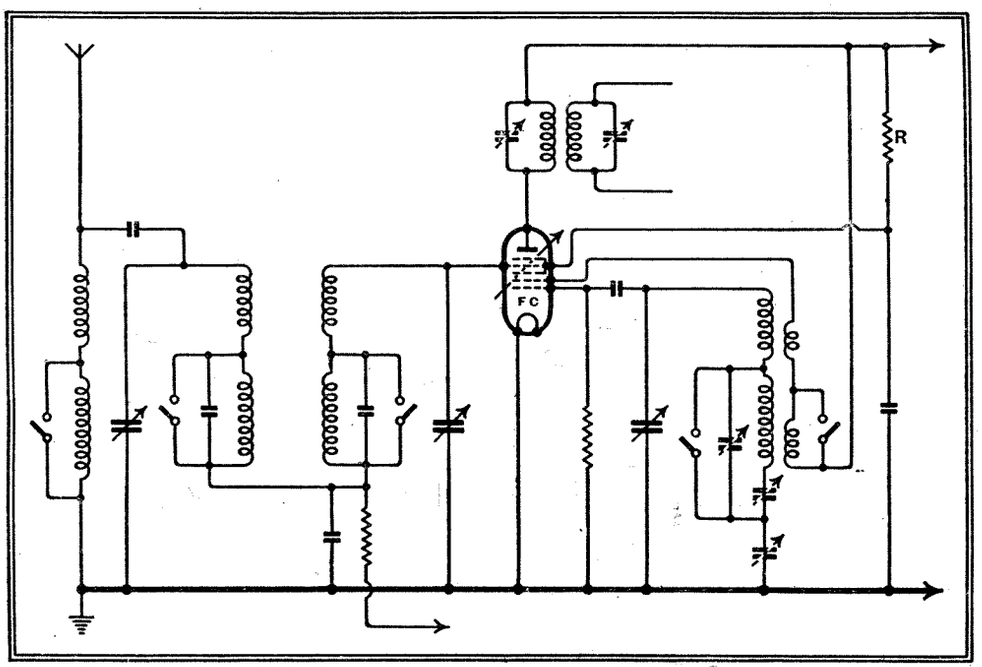



Fig. 1.—Frequency-changing circuit of a battery receiver. What are the faults that could cause intermittent signal cut-outs?

### Bad Assembly Work

Fig. 1 shows the heptode frequency changer circuit of a battery superhet which gave trouble by intermittently cutting out. Study of the diagram will suggest a number of fault possibilities that could account for the trouble, assuming that the fault is known to be somewhere in the frequency-changer stage. It is unlikely, however, that the actual fault would be thought of. Actually, the trouble was due to intermittent shorting between screen and filament, the fault being external to the valve. The screen feed and decoupling resistance R had been wired underneath the valveholder and was "shorting" against one of the filament sockets. A continuous short-circuit would be most easy to find by meter testing, but if it chose to be intermittent, as was the case with the receiver mentioned, it might take a little finding unless the assembly weakness was noticed by inspection.

Unfortunately, there is always the possibility of there being an assembly de-

**Intermittent Faults—**

fect in some part of the receiver that is covered by a screening can, but until there is some definite indication it is not advisable to go to the trouble of lifting off all the screening covers for inspection purposes. The crude but often usefully employed operation of jolting screening cans will sometimes give the necessary indication. Fig. 2 illustrates a case in point. A screened anode coil assembly carried the anode feed resistance, which, however, had been mounted so that it projected too far out and was touching the inside of the screening can. The receiver came on to the bench because it gave trouble in the form of very intermittent cut-out. It was found that jarring the chassis heavily, while it was out on the bench, would nearly always cause momentary cut-out. Closer investigation showed that quite a light tap on the screening can of the anode coil assembly would also cause a cut-out, and when it was found that the occurrence, and duration, of the fault symptom could be brought under complete and definite control by applying very slight pressure to the screening can the fault was as good as found.

### Tilting the Chassis

Many readers are familiar with the case of a fault symptom coming and going with the tilting of a chassis, no vibration being required. If the fault symptom can be made to start and stop and to come under quite definite control by tilting the chassis in some particular way the control thus exercised will probably be associated with the strain that is put on to the chassis. Close examination, based on this assumption, should lead to discovery of the fault. An example was that of a superhet which had developed intermittent drop of volume. This receiver had a ganged condenser which was floated on soft rubber cushions, and the fault was that of an intermittent high resistance developing at the joint between the condenser and an earthing bond. Holding the chassis at one particular angle to the bench put this bond under strain, and slight movement of the chassis about this position made the fault start and stop quite definitely.

If very erratic results are obtained by moving the chassis the possibility of there being a loose piece of metal which is causing intermittent shorting should be considered. This possibility is not at all far-fetched because the writer has met quite a number of cases where cut wire ends and "splashes" of solder have been left inside screening cans. In one particular case a receiver had become completely dead as regards reception. The chassis was taken out of the cabinet and as soon as it was turned upside down for testing purposes the fault cleared and perfect results were obtained. The chassis was turned back again, with no recurrence of the fault, but as soon as it was turned upside down for the second time the reception cut off. The trouble was caused by a loose piece of bare wire adrift inside the screening can of the oscillator coil assembly.

When inspection and probing do not lead to the discovery of the cause of intermittent trouble it becomes necessary to keep the receiver running, to let the fault choose its own time to come on, and to trace it by meter tests, or other means, when it does show up. While the receiver is "on soak" everything should be made ready to enable as much information as possible to be gained when the fault symptom does occur.

There is a very broad, but exceedingly useful, classification which can be made of intermittent faults: (1) Faults which affect the HT consumption of the receiver, and (2) faults which do not affect the HT consumption. To know which of these two categories applies sometimes enables substantial progress to be made towards the tracing of the fault. It may, therefore, prove to be useful to insert a milliammeter in the main HT feed line and to note what happens to the reading when the fault comes on. There is one danger possibility in using a milliammeter in this manner. The fault may turn out to be of a kind that will produce a heavy current surge and damage the meter. Knowledge of the general character of the fault symptoms may indicate that this danger does not exist in a particular case, but if there is the slightest doubt on the matter it will be wise to find out first what happens to the HT volts when the fault develops. A preliminary soak test with a voltmeter in circuit will show if there is anything in the way of intermittent HT shorting taking place.

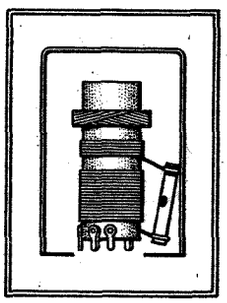


Fig. 2.—An anode feed resistance "shorting" on to a screening can. Pressure on the can will give the clue.

If the receiver employs Class B or QPP output it necessarily follows that the milliamps will be wildly fluctuating if the receiver is kept on soak with a broadcast signal tuned in. Even with single triode and pentode outputs, or with Class A push-pull, some receivers will show a certain amount of milliamp fluctuation on an outside signal, this effect being dependent upon the biasing conditions. If there is any fluctuation on an outside signal that will be likely to prove disconcerting when the fault comes on (and the behaviour of the milliammeter needle becomes of importance), it will be advisable to do the soak testing on an artificial signal of constant amplitude and modulation, such as would be provided by a testing oscillator.

Of all the various kinds of difficulty that are produced by intermittent faults the worst undoubtedly are those associated with the receiver which gives intermittent trouble while the chassis is in the cabinet but which works perfectly and continuously so long as the chassis is outside the cabinet and is on the bench. Such cases sometimes crop up with mains receivers, and in these cases the faults are almost invariably those that are dependent upon temperature rise. If the extra temperature attained when the receiver is completely put together is a controlling factor it will be found, of course, that the fault never comes on until the receiver has been kept running for a period. The chances are, too, that if the receiver is switched off, allowed to cool down, and is then switched on again, the same amount of time as before must be allowed to elapse before the trouble develops. Faults dependent upon temperature are quite common, but, fortunately, it does not often happen that the chassis must be in the cabinet for sufficient temperature to be gained to make the fault come on. When such a case does arise it can be very awkward, particularly if the fault happens to be an intermittent one of brief duration. If conditions are so bad that great difficulty is experienced in trying to track down the location of the fault while the chassis is in the cabinet it will be advisable to get the chassis out and to bring up the temperature either by placing a temporary cover over it or by the brute force method of warming with an electric stove. The latter method should be used with some caution, care being taken not to overdo it, and thus cause scorching, or melting of condenser wax, or warping of dials, etc.

It should be noted that "temperature intermittents" can arise with loud speakers, and it does not follow that the receiver chassis must necessarily contain the fault.

When the fault shows its symptoms in a receiver that is on soak test, close observation should be made of all the characteristics of the symptoms. If the location of the fault does not become immediately and plainly apparent it becomes necessary to consider the various possibilities that would account for the observed effects. If the possibilities are large in number, a series of eliminating tests may be necessary. The main purpose of using a milliammeter in the manner suggested above is, as a matter of fact, to give a start to the process of elimination.

### Process of Elimination

Sometimes one additional test will clear the air immensely and reduce the number of fault possibilities to an extent that makes the tracing of the fault quite easy. As an example can be mentioned the case of an A.C. mains superhet which intermittently dropped in volume. A milliamp test showed that the fault was associated with a considerable drop in HT current. The latter information was worth gaining, and brought down the number of fault possibilities considerably, but a further test was made to find out if the smoothed HT volts rose or fell when the fault came on. It was found that the volts dropped, and the fact that both current and volts went down made it obvious that some tests on the HT supply system would be useful.

**Intermittent Faults—**

The rectifier was suspected first and proved to contain the fault. It was a valve rectifier of the indirectly heated type and had a faulty cathode connection.

Dry joints are prolific causes of trouble. Any poorly made joint that makes and breaks contact or, worse still, sets up a varying contact resistance will cause intermittent trouble. One has only to think of the number of soldered joints contained in the average receiver to realise that the varieties of effect that may be caused by faulty joints defy any attempt at reasonable classification.

It is as well to adopt a permanent attitude of suspicion towards all soldered joints, including even those of valve pins and caps. Really bad joints can generally be found by inspection and probing, but there should be no hesitation about using a soldering iron to freshen up any joint regarding which there may be the slightest doubt.

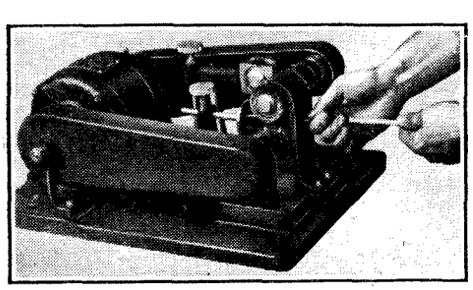
Any high resistance produced by a dry joint must necessarily have very pronounced effects in any low-potential circuit designed with low resistance as an important factor. Intermittent but severe distortion has been known, for example, to be caused in a Class B receiver by a dry joint in the grid circuit of the Class B valve.

Cases quite frequently occur where signals fade, but can at once be restored to normal by any slight electrical surge that can be produced in the receiver, and dry joints are commonly involved in such cases. One mains superhet receiver developed bad intermittent fading on medium waves, but if, while the signal strength was down, the receiver was switched off and on, or the wave switch operated, or even a voltmeter applied to any anode or screen, the full sensitivity of the receiver would be immediately restored. The clearing of the fault by the application of the voltmeter was an irritating effect that will probably be familiar to many readers. In the case under consideration the fault was no more than a bad joint on the medium-wave oscillator coil assembly (litz wire). The high resistance developed by this joint was responsible for the fading, and it became evident that this resistance would break down under the influence of the slight "kick" produced by the methods mentioned.

The owner of one particular receiver worked himself into a rare state of indignation because the reception would occasionally drop in volume, and he found it necessary to go upstairs and to operate a certain bedroom-light switch in order to restore normal reception. This, again, proved to be a dry joint case, the fault being at the top (grid) cap of the frequency changer valve.

The possibility of a dry joint being responsible should never be overlooked if the cause of an elusive intermittent crackle is being sought.

*(To be concluded.)*



**MOTOR-DRIVEN WIRE STRIPPER for removing the insulation from any type of wire by means of rotating steel wire brushes. A thumbscrew adjusts the distance between the brushes to suit the wire diameter, while an adjustable stop behind the brushes controls the length of the stripping. It is stated that this American-made machine will remove enamel and gummy insulation embedded in stranded wires ; also that it will handle fine litz wire.**

# Television Programmes

**An hour's special film transmission, intended for demonstration purposes, will be given from 11 a.m. to 12 noon each week-day.**

| Vision | Sound |
|---|---|
| 45 Mc/s | 41.5 Mc/s |

THURSDAY, OCTOBER 20th.

**3,** Jack Jackson and his Band. **3.30,** British Movietonews. **3.40,** 183rd edition of Picture Page.

**9,** Cabaret, including Steve Geray and Magda Kun. **9.35,** Gaumont-British News. **9.45,** 184th edition of Picture Page. **10.15,** News.

FRIDAY, OCTOBER 21st.

**3-4,** "Juno and the Paycock," a tragedy by Sean O'Casey. Cast includes Harry Hutchinson and Maire O'Neill.

**9,** Elsie Carlisle and Sam Browne. **9.10,** "So Ended a Great Love"—feature film with Paula Wessely. **10.40,** News.

SATURDAY, OCTOBER 22nd.

**3,** A tour of the O.B. Unit in action, with Leslie Mitchell as guide. **3.20,** Cartoon Film. **3.30,** Eric Wild and his Band.

**9,** "Now for Fun"—Cabaret from Grosvenor House. **9.30,** Gaumont-British News. **9.40,** O.B. from the Hammersmith Palais. Viewers are invited to the dancing with Oscar Rabin and his Band. **10.10,** News.

SUNDAY, OCTOBER 23rd.

**8.50,** News. **9.5,** Cartoon Film. **9.10-10.30,** Theatre Parade : a play from a London theatre.

MONDAY, OCTOBER 24th.

**3,** Local O.B. : Water Divining. **3.20,** British Movietonews. **3.30,** "Pest Pilot"—a musical burlesque by Roger MacDougall and Allan MacKinnen.

**9,** Telecrime No. 2. **9.20,** Gaumont-British News. **9.30,** Your Television Set, No. 1. An illustrated talk by the Senior Maintenance Engineer on how to get the best out of your receiver. **9.40,** Cartoon Film. **9.45,** Ballet. **10.5,** News.

TUESDAY, OCTOBER 25th.

**3,** Local O.B. : Horsemanship Demonstration in Alexandra Park. **3.20,** Gaumont-British News. **3.30,** Re-View—Songs and Scenes from Bygone Shows.

**9,** British Movietonews. **9.10,** "Juno and the Paycock" (as on Friday at 3 p.m.). **10.10,** News.

WEDNESDAY, OCTOBER 26th.

**2.40,** Local O.B. **3,** O.B. from Highbury—England v. The Rest of Europe, Soccer Match. **3.45,** Forecast of Fashion. **4-4.35,** Soccer O.B. continued.

**9,** Starlight. **9.10,** Cartoon Film. **9.15,** News Map III. **9.30,** Gaumont-British News. **9.40,** "Cast up by the Sea," a Stephen Leacock melodrama. **10.10,** News.

# News from the Clubs

### *Exeter and District Wireless Society*

**Headquarters:** Y.W.C.A., 3, Dix's Field, Southernhay, Exeter.
**Meetings:** Mondays at 8 p.m.
**Hon. Sec.:** Mr. W. J. Ching, 9, Sivell Place, Heavitree, Exeter.

Various members brought their sets along to the October 3rd meeting for demonstration. Several interesting sets were brought, and members showed particular interest in those working on 56 and 112 Mc/s. Both straight and super-regenerative sets were shown. On October 10th the Society's amplifier was successfully demonstrated.

The Society's programme from November 7th to the end of the year is as follows:—

**November 7th.**—Demonstration of *The Wireless World* Straight Six, including 4-watt and 12-watt push-pull amplifiers, by Mr. F. W. Saunders.
**November 14th.**—An illustrated lecture entitled "Radio and the Moon," by Mr. D. R. Barber, B.Sc., F.R.A.S., of the Norman Lockyer Observatory, Sidmouth.
**November 21st.**—Loud speaker demonstration by a representative of Voigt Patents.
**November 28th.**—Details will be announced later.
**December 5th.**—Lecture entitled "Electricity in Harness," by Mr. W. S. Pyrah.
**December 12th.**—Lecture entitled "From Power Station to Power Point," by Mr. F. S. Rumball.

The programme for October was announced in our September 22nd issue.

### *Golders Green and Hendon Radio and Scientific Society*

**Headquarters:** Regal Cinema, Finchley Road, London, N.W.2.
**Meetings:** Second and fourth Wednesdays of the month at 8 p.m.
**Hon. Sec.:** Lt.-Col. H. Ashley Scarlett, 60, Pattison Road, London, N.W.2.

The following programme has been arranged:

**October 26th.**—Annual Prize Distribution by Mr. E. Hubbard.
**November 9th.**—Lecture entitled "Television Transmitting Equipment," by Mr. H. A. M. Clark.
**November 23rd.**—Lecture entitled "Short Waves," by Mr. E. L. Gardiner.
**December 14th.**—Lecture entitled "High Fidelity Reproduction," by Mr. P. G. A. H. Voigt.

Members are asked to note that a weekly morse class has been organised.

### *Croydon Radio Society*

**Headquarters:** St. Peter's Hall, Ledbury Road, South Croydon.
**Meetings:** Tuesdays at 8 p.m.
**Hon. Pub. Sec.:** Mr. E. L. Cumbers, 14, Campden Road, South Croydon.

The Society have commenced the new season's activities, and the programme will be published at an early date. To-day, October 20th, a loud speaker night will be held.

### *Maidstone Amateur Radio Society*

**Headquarters:** 244, Upper Fant Road, Maidstone.
**Meetings:** Tuesdays at 7.45 p.m.
**Hon. Sec.:** Mr. P. M. S. Hedgeland, 8, Hayle Road, Maidstone.

The Society's programme from November 1st to January 10th is as follows:—

**November 1st.**—Lecture entitled "Measuring Instruments," by Mr. S. R. Wilkins, of the Automatic Coil Winder Co.
**November 15th.**—A lecture entitled "Interference Suppression," by a representative of Belling and Lee.
**November 29th.**—A lecture entitled "The Design of Valve Amplifiers, including Contrast Expansion," by Mr. Nixon, of the General Electric Co.
**December 13th.**—A lecture entitled "The Commercial Applications of the Piezo-electric Crystal," by Mr. H. G. Menage, of R. A. Rothermel.
**January 3rd.**—A lecture entitled "Some Stepping Stones to Loud Speaker Progress," by Mr. G. S. Taylor, of the Whiteley Electrical Radio Co.
**January 10th.**—Annual General Meeting.

### *Dollis Hill Radio Communication Society*

**Headquarters:** Braintcroft Schools, Warren Road, London, N.W.2.
**Meetings:** Alternate Tuesdays at 8.15 p.m.
**Hon. Sec.:** Mr. E. Eldridge, 79, Oxgate Gardens, London, N.W.2.

On October 4th Mr. A. Turner began his lecture on "Short-wave Transmitters and Receivers." This will be resumed on November 15th.

The following programme has been arranged:—

**November 1st.**—Mr. D. N. Corfield will lecture on "The Alignment of Superhet Receivers."
**November 15th.**—Mr. A. Turner will continue his lecture on "Short-wave Transmitters and Receivers."
**November 29th.**—Junk Sale.
**December 13th.**—Exhibition of home-constructed apparatus.

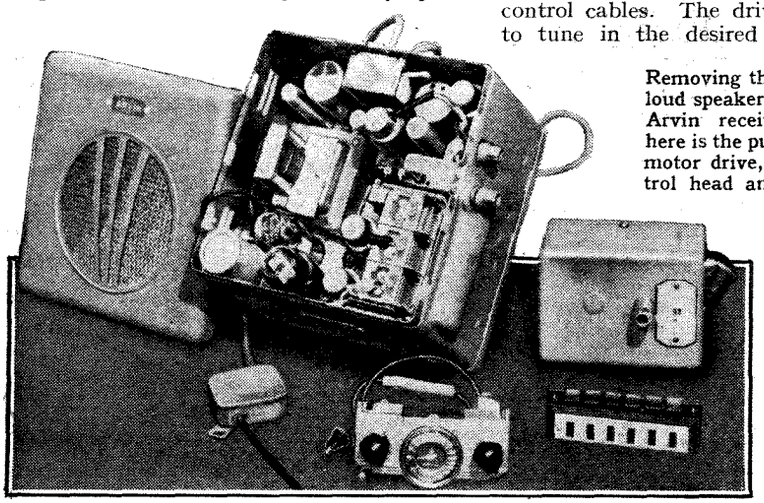
# Car Radio Equipment

## REVIEW OF THE SETS SHOWN AT THE MOTOR EXHIBITION

TAKING their place this year as an officially recognised motor car accessory, car radio receivers are being shown either by the makers or by approved distributors at the Motor Exhibition now being held at Earls Court.

Whilst fundamentally the circuits employed follow current wireless practice, the designer of a car radio receiver has some special problems to solve. Possibly the most difficult of these is the matter of control, by which is meant the tuning, switching on and off, varying the volume of sound to suit the tastes of the car's occupants, and the change-over from medium to long waves.

These problems were, of course, tackled at the outset, a system of remote control using flexible cables being frequently adopted. Needless to say, as only quite short and low aerials can be employed, receivers of exceptionally high sensitivity are required, and so far as the models seen at this year's Show are concerned, they are without exception superheterodynes.



Removing the side carrying the loud speaker gives access to the Arvin receiver. Shown also here is the push-button unit and motor drive, the standard control head and aerial matching device.

Possibly the universal adoption of the superhet circuit was influenced largely by the ease with which AVC could be obtained, for this feature is a most important one in sets of this kind.

Most of the modern sets have one RF stage before the frequency changer, and both these valves, as well as the IF stage, are included in the AVC circuit. Thus very good control is obtained.

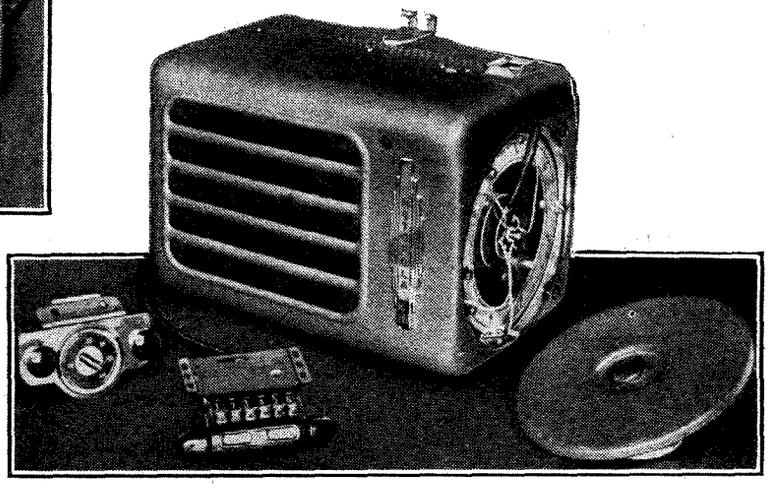
Hitherto an elaborate array of suppression devices was needed to eliminate ignition and dynamo interference. Each sparking plug had to be fitted with a resistance, a resistance was usually needed in the distributor lead, while condensers had to be connected between the dynamo brushes and the casing.

Some engines did not take kindly to these noise-suppression devices, and the outcome of this has been that means have now been devised to filter out the interference before it reaches the set, the necessary filters being included in the aerial lead or embodied in the input circuit in the set itself.

Thus with the modern car radio receiver only in exceptional cases is it necessary to employ interference suppression units.

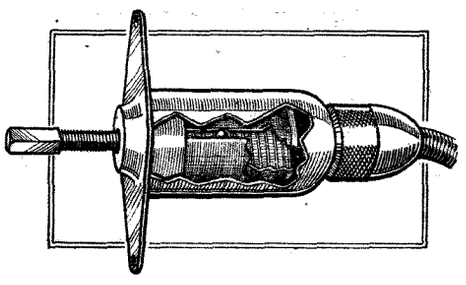
For example, in the Arvin car radio receiver, an anti-interference system somewhat similar to that used with ordinary domestic receivers is employed. Close to the aerial is mounted a step-down transformer, and from this a screened low impedance feeder is taken to the set. Every part of the set is exceptionally well screened, and it is stated this usually suffices to ensure a satisfactory silent background.

The most interesting development is possibly the new system of tuning and control now embodied in many of this season's car radio receivers. With the customary system of remote control only quite a small unit need be fitted within easy reach of the driver, whilst the remainder of the set can be housed in any convenient part of the car within the latitude permitted by the length of the flexible control cables. The driver has, of course, to tune in the desired station manually, with occasional glances at the dial in order to follow the movement of the pointer.



(Right) Motorola Model 8-60, revealing station selector gear for motorised push button tuning, standard control head and Acoustinator unit.

In order to simplify matters, the idea of press-button tuning, which was one of the outstanding features of the recent Radio Show, has been applied to car radio receivers. Of the various possible systems, that which employs a motor drive lends itself best for remote control, and this is the one that is being used in the new sets.



The Spot Tuning unit fitted to Motorola car radio sets.

The motorised drive evolved for the Arvin receivers is a separate unit which can be fitted to any of their sets. It is inserted between the flexible cable from the control lead and the condenser spindle. It does not affect the manual control, which can still be used for tuning if required.

A multi-wire cable joins the motor unit to the push-button panel, on which are six switches. Each push-button can be made to tune-in any desired station, and the adjustment is extremely simple. A button is pressed and the manual control is rotated until one of the required stations is tuned in exactly. This procedure is repeated on the remaining five buttons in turn, and henceforth any of the six stations so selected can be tuned in merely by a momentary depression of the appropriate button. It is quite simple to change any or all of the selected stations at a moment's notice.

There are three different models, all superheterodynes, in the Arvin range and each includes an RF stage and two tuned circuits before the frequency changer.

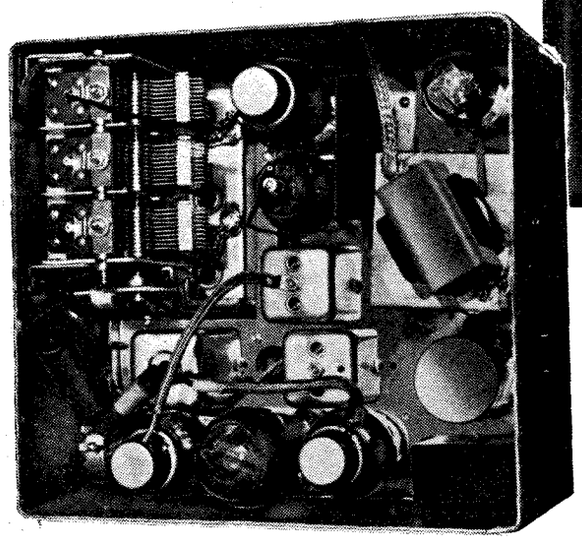
The cheapest model, known as the Arvin Standard, or Model 19B, covers the medium waveband only. It is a single unit embodying a 6½in. moving-coil PM loud speaker and gives an output of 4 watts. The Standard control head includes reduction drive for tuning, illuminated dial, tone and volume controls and on-off switch, also a fuse for the receiver. The price is 12½ guineas.

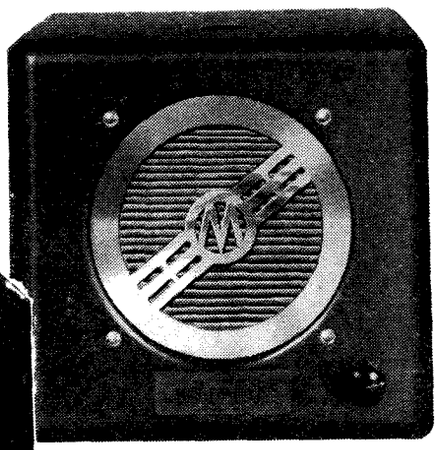
The Master Sportsman, Model 32B, has a similar circuit arrangement, but it provides for long as well as medium waveband reception. It is also of single-unit construction and gives 5 watts undistorted output. This model costs 15½ guineas.

**Car Radio Equipment**—

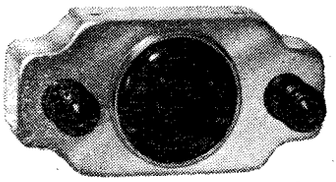
Model 42B is a dual-waveband set embodying all the features already enumerated, and in addition it includes a Class B push-pull output stage capable of supplying 10 watts to an 8in. moving-coil loud speaker. In this case the speaker is housed in a separate cabinet, and the price complete is 22 guineas.

All Arvin receivers are powered by a vibrator HT unit in which is used a full-wave thermionic rectifier. All the models are available for 6- or 12-volt operation at the same price, while the motorised push-button tuning can be included in each of them for an extra charge of six guineas. Arvin sets are shown by Stedall and Co.





Masteradio receiver with and without loud speaker cover plate in position.



Standard control head for Masteradio sets.

Two simplified forms of tuning have been developed for the Motorola car radio sets which are shown by R. M. Papelian. One is a press-button motorised system which is embodied in their Model 8-60, and the other takes the form of mechanical pre-selection described as "Spot Tuning," and operates in conjunction with the ordinary manual tuning control.

The Spot Tuner is a small cylindrical unit which can be interposed between the control head and the flexible cable to the tuning condenser. Inside the tuner housing is a screw-threaded member, which revolves with the cable, and between it and a retaining sleeve is a tiny steel ball. When the tuning knob is rotated this ball moves laterally in the housing, being prevented from rotating round the threaded member by a lateral slot. The ball is held firmly against the screw-thread by spring tension.

The method of selecting stations is as follows; a station is tuned in in the usual way, then the outer casing of the Spot Tuner is slipped back along the cable, thus exposing the mechanism. The ball is then pressed firmly against the brass raceway by placing one jaw of a pair of pliers on the ball and the other jaw on the opposite side of the housing. This makes a small indentation in the thread of the brass screw. Repeat this operation for about half a dozen stations. Now, when the tuning knob is rotated and the position of each of the pre-selected stations reached, the ball will snap into the indentation in the screw thread and thus "spot" the station. Tuning is thus effected without looking at the dial.

The selected stations can at any time be changed for another list, as there is a second screw thread cut parallel with the other, and it is only necessary to disconnect the spot tuner from the shafting, rotate it so that the ball moves to the extreme end of the thread when it will drop into the unused raceway.

Six valves are used in the Motorola car radio receivers in a superheterodyne circuit consisting of one RF stage, a frequency changer, one IF amplifier, double-diode-triode for detector, AVC and first AF, and a pentode output stage. As three valves are included in the AVC circuit, the output from the loud speaker is maintained at a constant level despite wide changes in signal strength. HT is provided by a vibrator unit and a cold-cathode full-wave rectifying valve. Three models are now available and all provide for medium- and long-wave reception. Wavechange is effected by push-button switches.

The Model 8-50 has an 8in. PM moving-coil loud speaker included in the receiver cabinet and the operation is by ordinary manual remote control through flexible driving cables. With a 12-volt battery the consumption is 2.5 amps and a power output of 5 watts is obtained. The price is 15 guineas for either 12- or 6-volt operation.

This set can be obtained fitted with the new Motorola Acoustinator, and the Spot Tuning system already described. In this form it is known as the Model 8-50 De Luxe, and its price is £16 19s. 6d. The Acoustinator enables the sensitivity of the set to be adjusted for best long-distance or local reception as the case may be, and it also includes a comprehensive tone control.

Push-button motorised tuning is used in the Motorola Model 8-60, though otherwise the circuit is sensibly the same as the other models. The motor tuning operates independently of the manual control, and its incorporation does not preclude tuning-in stations with the usual cable-operated remote control. Six push-buttons are provided, one of which operates the waveband switch, and the selected stations can be either in the medium or in the long wavebands. The price of this set is 20 guineas.

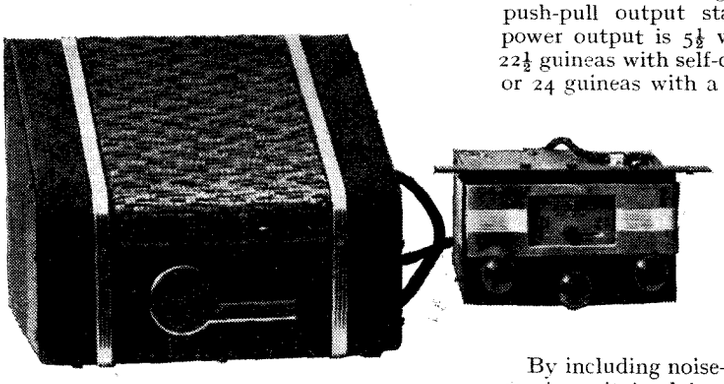
Five models are now included in the range of car radio receivers made by Masteradio. All are superheterodynes embodying one or more RF stages. Cable-operated remote control is standardised, but motorised tuning with push-buttons can be fitted to any of the sets if required.

The system employed by this firm enables any or all of the push-button selected stations to be changed at a moment's notice and while actually travelling along the road.

The Model 101, which costs 13½ guineas, includes six valves, one of which is a full-wave rectifier; a vibrator is employed for HT supply in all these sets.

There are also available two seven-valve sets; one, the Model 297, has the loud speaker combined in the set, while in the Model 297S it is housed in a separate container. The principal features of this set are medium- and long-wave bands, an RF stage before the frequency-changer, Class B output giving 5 watts of undistorted power and a novel inter-station noise silencer. Continuously variable tone control is provided. On 12 volts the total consumption is 2.5 amps, while with a 6-volt input 5 amps are required. With self-contained PM loud speaker the price is 16½ guineas, and as a two-unit model with separate loud speaker it costs 18 guineas. Tuning is, of course, by remote control, which can be either a steering-column unit or a dashboard fitting.

The most interesting set in the Masteradio range is the Model 399, which has an 8-valve superheterodyne circuit and a full-wave rectifying valve for the HT vibrator. This set has two RF stages, using the new low-noise level RF pentodes, an octode frequency changer, one IF amplifier, a combined diode detector and first AF stage, then a stage that provides AVC, inter-station noise silencing and noise limitation on signals, then an AF stage, and finally a Class A push-pull output stage. The undistorted power output is 5½ watts, and the price is 22½ guineas with self-contained loud speaker, or 24 guineas with a separate loud speaker.



Two units of Philco Model M521 receiver. On the right is the control head embodying the frequency changer valve.

By including noise-silencing circuits in the receiver, it is claimed that quiet reception free from any trace of ignition electrical noise is normally effected without the need for suppression devices of any kind.

All these sets can be fitted with a motorised push-button tuning unit at an extra cost of 6 guineas.

Delco-Remy and Hyatt are showing a new Philco car radio receiver which makes its début at this Exhibition. It is known

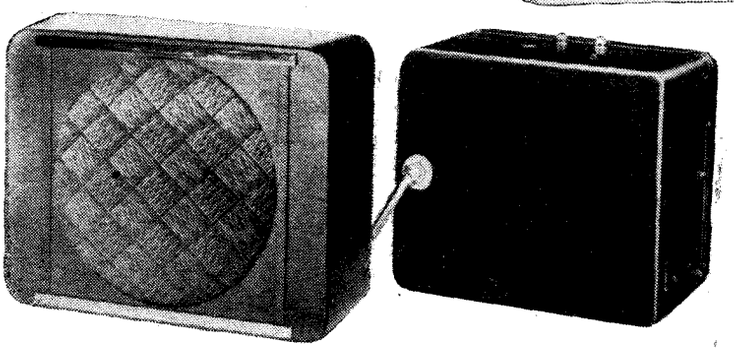
**Car Radio Equipment—**

as the Model M521 and embodies a novel system of remote control tuning. The customary Bowden cable form of controls are dispensed with, and the only link between the receiver and the control unit is a multi-wire cable which can be of any length.

The set is a five-valve superheterodyne and it is built in two units. One, the control head, includes the frequency-changer valve and all tuned circuits. In addition, there is the control for a new system of volume level adjustment which makes use of negative feed-back.

The output from the frequency-changer is taken by a low-impedance cable to the main unit, in which is contained the IF stage, detector and AVC circuits, AF amplifier and vibrator HT supply equipment. The power output is approximately 2.5 watts. Noise suppression filters are included in both the control head and the main unit, so that engine-noise suppression devices are reduced to the minimum.

Both medium- and long-wave bands are covered, and the price is 13 guineas. Despite these interesting and new developments the set is actually the lowest-priced one in the Philco range.



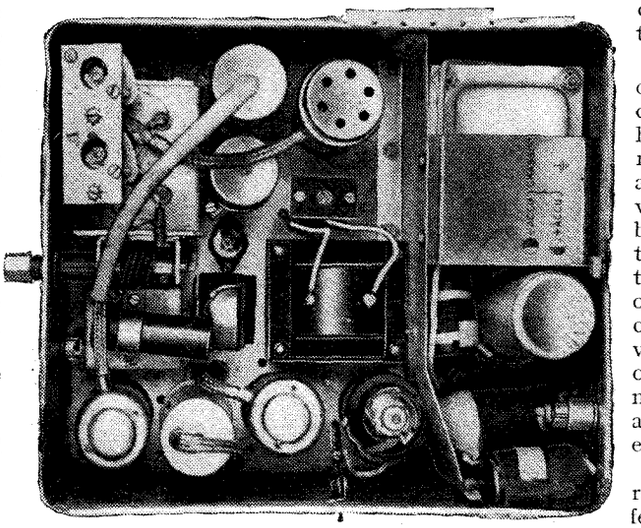
Interior of Philips receiver is shown above. Note the large output transformer in centre. (Left) Two-unit construction of models 262B and 263B.

There is a six-valve superhet, the Model K628, costing 15 guineas, a seven-valve de luxe model, type K728, which has a push-pull Class A output stage and provision for an extension loud speaker, and a set designed especially for limousine cars, coaches, yachts, etc. This model, the L728, a seven-valve superhet, includes an RF stage, the customary FC, IF, Det. and AVC circuits, but has push-pull pentodes in the output stage. Vibrator and full-wave rectifier valve supply the HT. It consumes 3.3 amps at 12 volts and the price is 20 guineas. The loud speaker fitted is a 9½in. model, an unusually large size for sets of this kind.

On the Philips stand, which firm enjoy the distinction of pioneering the idea of ignition interference elimination without engine suppressors of any kind, are shown some new Motoradio receivers. The improvements effected have been towards simplification of the set, at the same time giving an improved performance. All the receivers are actually identical so far as the essential features of their respective circuits are concerned, and their principal differences are in the method of connecting the heaters of the valves for 6- or 12-volt operation, and in the location of the loud speaker. In some this is built in with the receiver, while in others it is a separate unit.

The circuit employed is a superheterodyne consisting of an octode frequency-changer, one high-gain IF stage, a double-diode-triode functioning as detector, AVC stage and first audio amplifier, which is resistance-capacity coupled to a pentode valve giving 3¼ watts output. HT is provided by a synchronous vibrator-rectifier. Limiting the set to four valves has enabled the total consumption to be kept down to a low figure, and on 12 volts it is only 2¼ amps. The 6-volt versions of these sets consume 4½ amps.

Good discrimination between signal and image signal frequencies is ensured by the adoption of a high intermediate frequency, that employed being 470 kc/s. Medium and long wavebands are covered.



The self-contained 6- and 12-volt models have a 6¾in. diameter loud speaker, and they cost 13½ guineas each. In the other sets a larger and more sensitive loud speaker is used; the price of these is 15½ guineas for 6- or 12-volt operation.

A remote control unit of the cable-operated type is employed, and this can be fitted either on the dashboard or on the steering column.

Ferranti adopt a two-unit construction for their car radio receivers. There are two models, one for 6- and the other for 12-volt operation, but the circuit is sensibly the same in both. It is a five-valve superheterodyne having one RF stage, a heptode frequency-changer, one IF valve, double-diode-triode for detection, AVC and first AF amplifier, followed by a pentode output stage. HT is provided by a vibrator and a full-wave rectifying valve, this part of the equipment being contained in the loud speaker unit. The loud speaker is a PM moving-coil model and has a 7in. diaphragm.

The total consumption of the 12-volt model is approximately 4 amps, while that of the 6-volt set is 6 amps, and the price is 16 guineas.

The customary form of remote control through flexible driving cables is employed, and the control head has an illuminated dial marked in station names. Medium and long wavebands are provided, wavechange being effected by a push and pull motion of the tuning knob. The only other control is a combined volume and on-off switch, the latter being capable of being locked by a key to prevent unauthorised use. A feature of the Ferranti sets is that only a minimum of suppression devices are needed in the car's electrical equipment.

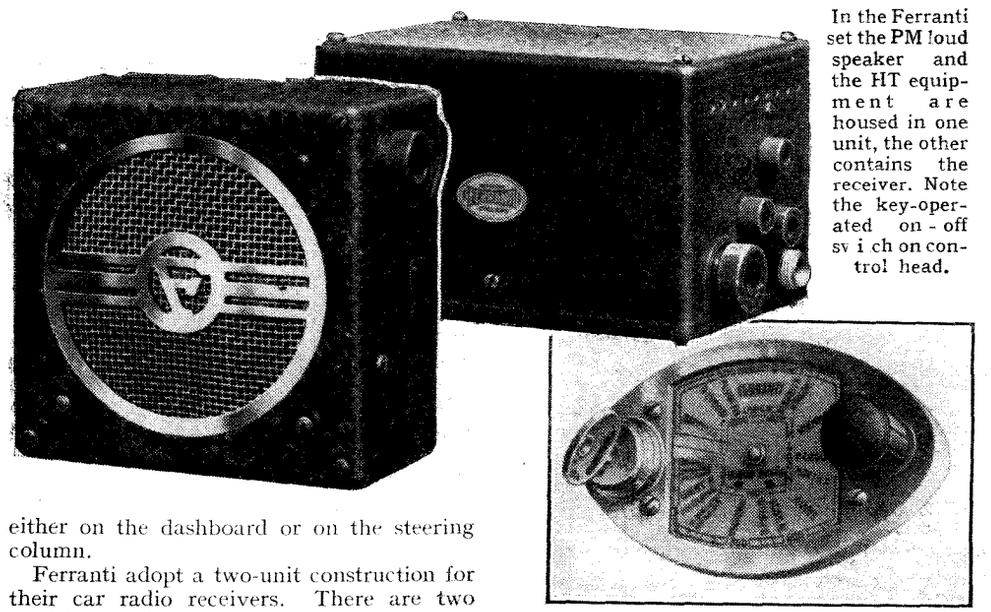
All the firms making car radio receivers also supply several different kinds of aerial. They can be divided into three distinct types. There is the under-running board variety, usually consisting of a rod or tube and generally arranged in such a way that it discriminates between signals and electrical interference.

Some makers, Ferranti being one, flexibly support the under-chassis aerial to prevent it being carried away by any road obstruction.

Other types are intended for mounting on the outside of the roof of cars. They are designed to conform with the contours of the roof and have an attractive appearance.

The third standard pattern takes the form of a vertical rod, or short telescopic mast, that can be fitted to the side of the scuttle on the car, or with certain makes of car an aerial can be supplied that has a fitting to take the place of one of the front door hinge-pins.

Those intended for fitting underneath the running board, or chassis, are usually the cheapest form, prices ranging from 10s. 6d. to 16s., while the other patterns, which being visible are more attractively finished, cost from 21s. to 27s. 6d.



In the Ferranti set the PM loud speaker and the HT equipment are housed in one unit, the other contains the receiver. Note the key-operated on-off switch on control head.

***How a Receiver is Designed.—XXVII***

# All-wave Battery Set

## SHORT-WAVE OSCILLATOR PROBLEMS

*IN this article dealing with the design of an all-wave battery-operated receiver, the difficulties encountered in the oscillator circuit are discussed. The interdependence of the frequency-changing valve, the circuit, and the oscillator coil assembly is treated*

THE preliminary design of the early stages was discussed in the last article in this series, and it will be remembered that we decided to adopt one RF stage, frequency-changer, one IF stage, diode detector and a triode AF amplifier preceding the output stage. In addition to the medium and long wavebands it was decided to include two short-wave ranges covering about 12-100 metres.

Now, the details of the design of the RF side were not discussed. It was said simply that the triode-hexode frequency-changer would seem the most suitable valve provided that suitable coils were readily obtainable. In connection with coils the Wearite type P were considered as being especially convenient, since they are a standard range and have listed characteristics which seem close to those needed. It was pointed out, however, that the suitability of coils and valves in conjunction could only be settled finally by experiment.

It was decided, therefore, to construct an experimental tuner to settle this question. It should be understood that there was no doubt that the coils would be suitable as regards their main windings, the doubt arose in respect of the primary and reaction windings. The coils are normally used in conjunction with mains-type valves, which have higher values of mutual conductance than battery types. Consequently, we might expect to find that the primary of an RF transformer is on the small side for a battery valve, and still more important, the reaction coil of the oscillator may be too loosely coupled.

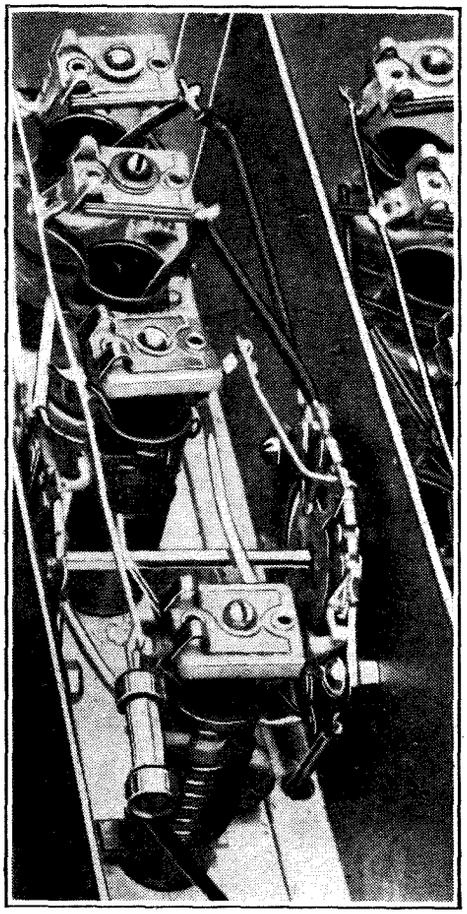
A trial using the Tungsram VP2D valve for the RF stage and the Osram X23 for the frequency-changer showed that the standard coils are in every way satisfactory on the medium and long wavebands. On short waves the performance was satisfactory on range 2 with a nominal coverage of 34-100 metres, save that in practice the minimum wavelength proved to be nearer 37 metres than 34 metres.

### Type of Oscillator

As one would expect, the greatest difficulty was encountered on range 1 with a nominal band of 12-36 metres. The lowest waverange is always the most troublesome, and the main difficulty arises in the oscillator circuit. Little, if any, difficulty would arise if it were possible to use the Colpitt's oscillator, but this is usually out of the question, for it demands a special gang condenser. In addition to the usual sections for the signal-frequency circuits two oscillator sections, each of double the normal capacity, would be needed.

A single oscillator section of normal capacity can be used with the modified Colpitt's circuit, but this is unsuitable for a wide tuning range. In general, a ratio of maximum to minimum wavelength of some 1.5-1, or at most 2-1, is all that can be provided with this circuit.

The next best oscillator for short waves is the Hartley circuit. For use with a multiple valve, such as the triode-hexode, a special gang condenser is again necessary. This time, however, the oscillator section must be of normal capacity, but both fixed and moving plates must be insulated from the other sections. This can be avoided by using a two-valve frequency-changer, for with a separate oscillator the cathode can be tapped up the tuned circuit and one side of it earthed. This is easy in a mains set with indirectly heated valves, but in a battery set the use of directly heated valves makes it necessary to use filament chokes which introduce problems of their own.



A view of one section of the experimental tuner showing the four coils of the aerial circuit with their associated switches and trimming condensers. The coils are mounted in ascending order of wavelength from the front.

For a battery set, therefore, one is practically forced to use the reaction-coil oscillator. It should be understood that the differences between the oscillators are chiefly in the initial design and are not reflected in variations in the performance of a receiver. For instance, if one has a receiver fitted with a reaction coil oscillator arranged to give the optimum injection to the mixer, then a change to the Colpitt's oscillator will not affect sensitivity, selectivity or signal-noise ratio if this oscillator is arranged also to give optimum injection. The differences between the oscillators lie in the ease of securing oscillation over a wide band, uniformity of output over that band, minimum stray circuit capacity, frequency stability, and so on.

### The Shortest Wavelength

The main difficulty with the reaction coil oscillator lies in obtaining tight enough coupling between the tuned and reaction coils without making the circuit capacity very high. There is usually little, if any, difficulty until one gets below 30 metres, and with mains valves of high mutual conductance there is no serious trouble above 10 metres.

It is always more difficult to make a circuit oscillate at high frequencies than at low or moderate frequencies because the effective dynamic resistance of the tuned circuit is lower. Furthermore, the turns on the coil are so few that it is difficult to secure adequate coupling between the coils. This is why the Colpitt's oscillator scores, for it does not depend at all on mutual inductance coupling.

For 12-30 metres a coil will have about six turns only with a diameter of about 0.5in. and a length of 0.75in. In general, the turns of the reaction coil must not exceed in number those of the tuned coil, otherwise the valve will oscillate at a frequency determined by the reaction coil in conjunction with its stray capacities instead of at the frequency of the tuned coil.

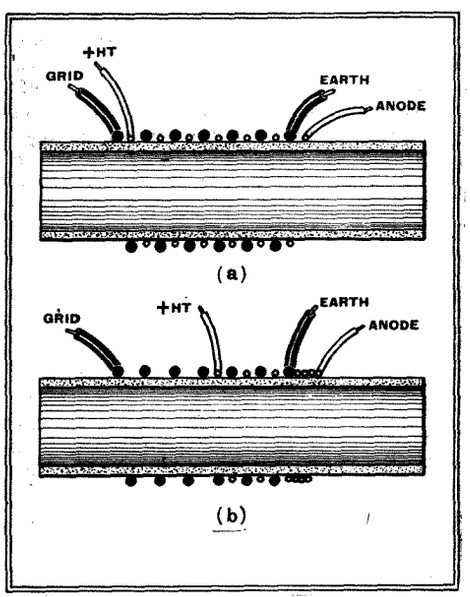
For safety's sake it is wise to use fewer turns on the reaction coil than on the

**All-wave Battery Set—**

main winding. The latter being fixed by the wavelength range desired, both are fixed, and the only variable left is the coupling. The value required depends on the efficiency of the tuned circuit as a whole, the mutual conductance of the valve and the output needed. With battery valves mutual conductance is fairly low, but to compensate for this in some degree the injection volts needed by battery mixing valves are also fairly low.

The tightest coupling is obtained by interwinding the tuned and reaction coils. When this is done the direction of winding of both coils *must* be the same, and in any case this is highly desirable for manufacturing reasons. With such a coil assembly the connections must be such that the "live" end of the tuned coil is immediately adjacent to the "earthy" end of the reaction coil, and the self-capacity is consequently very high. This results in a very serious restriction of the tuning range, and it is impracticable to adopt completely interwound coils.

On the other hand, the coupling is usually inadequate if the coils are wound end to end with their earthy ends together —the arrangement which gives the lowest self-capacity. Normally, we must adopt a compromise and interwind two or three turns of the coils at the earthy ends, placing the remaining reaction turns as closely as possible to the earthy end of the tuned coil. In this way it is usually possible to secure reasonably tight coupling with low self-capacity.




**A coil assembly with tuned and reaction windings completely interwound is shown at (a) and obviously gives a high self-capacity. At (b) is shown a practical arrangement where the coils are only partially interwound.**

The Wearite P coils are so wound, and using the PO4 with the X23 valve, experiment showed that oscillation could be secured from about 11.75 metres to some 32 metres. This is with an HT supply of 110 volts, representing the condition for a nominal 120-135-volt supply when the battery has run down somewhat. The maximum wavelength of 32 metres is that at which the valve ceased to oscillate, not that corresponding to maximum capacity of the tuning condenser.

At both extremes of the range the amplitude of oscillation was quite small, being about 1.5 volt only. The optimum amplitude for frequency changing with the X23 is some 4 volts with this HT supply rising to 6 volts with a battery of 150 volts. Experiment showed that with the standard coil assembly the satisfactory tuning range with this valve is about 13-28 metres, for an oscillator amplitude of some 3-4 volts is secured. Reception can be obtained over the wider range of 12-32 metres, but at lower efficiency in the bands of 12-13 and 28-32 metres.

### Wavelength Range

It was found that little could be done to improve the range by modifying the coil, and it was consequently decided that the best course would be to adopt the standard coil and accept a useful range of 13-28 metres only. The curtailment between 12-13 metres is not important, for there are few stations operating here. The next range, however, would need modifying to bring it down to overlap with range 1, and this would naturally result in a curtailment of the tuning range at the high wavelength end. To allow suitable overlap with range 1, range 2 should start at about 25 metres and it will then tune up to about 70 metres. As compared with our original intentions, we have in two bands a useful range of 13-70 metres instead of 12-100 metres. This curtailment is not very important, because there is little of general interest between 12 and 13 metres or between 70 and 100 metres.

A set of the P5 coils was modified for the new range by stripping off a suitable number of turns, and proved to give very satisfactory results. It was consequently decided to adopt this arrangement, and attention could be turned to the other details of design. Incidentally, it may be remarked that paper-dielectric condensers proved unsuitable on range 1 for inclusion within a tuned circuit, for they affected adversely both the efficiency and the accuracy of ganging. As paper condensers have to be used for the broadcast bands on account of the expense of mica types of large capacity, it proved necessary, therefore, to shunt them with mica condensers of moderate capacity.

*(To be continued.)*

# Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

### *Crystal Band-pass Filters*

I HAVE been interested to read Mr. Leigh's letter in which he criticises *The Wireless World* article of September 15th entitled "Crystal Band-Pass Filters." Since I was partly responsible for the information upon which that article was based I would like to comment upon his remarks.

I am pleased to find Mr. Leigh in agreement with me that crystal filters of this type can be constructed, and have useful features. I am less in agreement when he describes the subject as a rather difficult one, for it was partly to correct such a misconception that the article was written. In it the filters are explained in a simple manner which should be easily understood by readers having no specialised knowledge of filter design, and which helps to make clear that filters suitable for use in radio receivers can be both simple to design and understand, easy to install and adjust, inexpensive and reliable. I have recently placed in the hands of the Editor a number of articles in which these points are further explained and justified.

Admittedly there are highly specialised uses to which crystal band-pass filters can be applied, in which the requirements are very drastic, and a more elaborate theoretical treatment may be useful. But radio reception in its more usual forms is not one of these.

Mr. Leigh has introduced into his letter technical terms which were not used in the article. In his last paragraph he refers to the "second cut-off frequency of the filter," an expression not originally used. He makes free use of the term "anti-resonant frequency," a conception which I personally regard as misleading, since it is in no sense a resonant phenomenon, but merely a cancellation of two potentials (or currents) of equal magnitude and opposite phase. Dr. Robinson's well-known single-crystal filter, or crystal gate, has shown beyond a shadow of doubt that this so-called "anti-resonant frequency" can be shifted about through the action of a balancing condenser to any desired point along the frequency scale. The effect is well known to all experimenters who use crystal filter communication receivers. It seems, therefore, rather illogical to treat the "anti-resonant frequency" as an inherent property of the crystal.

The simple theory of the double crystal bridge depends upon the fact that a crystal has, and must have, a parallel capacity associated with it, as is shown in the equivalent circuit. This equivalent circuit was given in the article, and Mr. Leigh has taken it as the basis of his treatment, so that it becomes a mutually accepted basis for discussion. Although I shall show in my articles that there are cases when this equivalent circuit must be extended somewhat to account for observed facts, Mr. Leigh need have no fear that I intend to depart radically from it.

It is possible to counterbalance the effect of this parallel capacity by using a bridge and by putting another condenser in the other arm of that bridge. This was the simple theory of Robinson's single crystal bridge circuit, and we know how that theory has explained its behaviour very adequately. For instance, it is possible by means of the condenser to reach a symmetrical response curve (showing no anti-resonant frequency) or one showing a "zero" point in either side-band region and

# Broadcast Programmes

## FEATURES OF THE WEEK

THURSDAY, OCTOBER 20th.

Nat., 6.40, Sybil Thorndike and Emlyn Williams in extracts from "The Corn is Green." 7, Variety from Sheffield. 7.30, The Two Leslies present "Radio Pie." 8.30, Talk on the Mediterranean.

Reg., 6, Alfredo Campoli and his Salon Orchestra. 8.30, Excerpt from "Twinkle" presented by Clarkson Rose. 9, "Robert Owen," a Radio biography.

*Abroad.*

Rome Group, 8, "Tristan and Isolde," opera (Wagner).

Eiffel Tower and Lyons, 8.30, "The Magic Flute," opera (Mozart).

FRIDAY, OCTOBER 21st.

Nat., 8, Bebe Daniels in "What Happened at 8.20?" 9.25, "Advance in the Air"—Talk on Ocean Air Routes. 9.45, "Judith," a one-act opera with music written and conducted by Eugene Goossens.

Reg., 7.30, Jimmy Lunceford and his Orchestra, relayed from New York. 8, A Discussion on The Young Offender. 9.30, The Organ, the Dance Band and Me.

*Abroad.*

Milan Group, 8, "Il Ventaglio," operetta (Cuscina).

Naples Group, 8.15, "Miss Dollar," a musical adventure (Rupignè).

SATURDAY, OCTOBER 22nd.

Nat., 2.30, Motor Racing at Donington—The International Grand Prix. 4.25, Soccer Commentary: Wales *v.* England. 8, Music Hall, including Peter Dawson and Billy Russell. 9.25, American Commentary. 9.40, "Night Patrol"—a policeman's patrol in New York.

Reg., 2.30 and 3.5, Acts I and II of "Rigoletto," opera (Verdi), from the Sadler's Wells Theatre. 6, Musical Seesaw relayed from New York. 9, Jack Hylton and his Band, with numerous artistes.

*Abroad.*

Milan Group, 8, "Tristan and Isolde," opera (Wagner).

SUNDAY, OCTOBER 23rd.

Nat., 1.20, Troise and his Banjoliers. 5, "Treasures of our Churches"—Talk by Sir Eric MacLagan. 5.20, Schumann Recital by Alexander Kipnis (Bass). 9.35, Student Songs.

Reg., 6.15, Spelling Bee: Listeners *v.* Viewers. 7.10, "My Song for You," Paul England with Rae Jenkins, viola, and Clive Richardson, pianoforte. 7.30, World Concert from Canada. 9.5, Sunday Concert III, with Solomon, pianoforte.

*Abroad.*

Berlin Deutschlandsender, 7.10, Wagner Concert, conducted by Knappertsbusch.

Berlin Funkstunde, 7.10, "Paganini," operetta (Lehár).

MONDAY, OCTOBER 24th.

Nat., 7, Monday at Seven. 9.25, World Affairs. 9.40, Bizet Centenary.

Reg., 7.20, The Week on Wall Street. 9, "Between You and Me and the Mike"—Revue. 9.30, Reginald Foort at the Organ, with Billy Thorburn, Alan Paul and Ivor Dennis at three pianos.

*Abroad.*

Frankfurt, 7.10, "La Traviata," opera (Verdi).

Paris PTT, 10.45, "The Barber of Seville," comedy (Beaumarchais), in Esperanto.

TUESDAY, OCTOBER 25th.

Nat., 6.25, The Meaning of the Factory Act. 7.30, An Enquiry into Social Distinction—Occupations. 8, Showmen of England, III—Albert de Courville. 9.40, A Discussion on Private Enterprise and Public Ownership in Electricity.

Reg., 8.30, The Under Twenty Club, with Howard Marshall in the chair.

*Abroad.*

Konigsberg, 7.10, "Carmen," opera (Bizet).

Luxembourg, 9, Bizet Centenary Concert.

WEDNESDAY, OCTOBER 26th.

Nat., 3.10, Cesarewitch Commentary. 7.45, The World Goes By. 8.15 and 9.25, Symphony Concert from the Queens Hall. 10.10, "Men of Action"—play by Horton Giddy.

Reg., 6, Showmen of England, III. 8.15, Band Waggon. 9.15, Variety at Home.

*Abroad.*

Berlin Deutschlandsender, 7.10, "The Barber of Seville," opera (Rossini).

Naples Group, 7.30, "Dance of the Dragon Flies," operetta (Lehár).

at any frequency differing from resonance.

This theory has been extended to the double crystal bridge circuit, and has enabled results to be predicted which are now easily obtainable. These are that by changing the magnitude of the balancing condenser alone we can obtain a band-pass having one "zero" point on either side of the pass-band simultaneously, and we can vary the frequencies at which these "zeros" are obtained right up to infinity. It is also possible to use the balancing condenser to obtain a band absorption characteristic.

These results are explained on the assumption that a balance of the parallel capacities occurs, as shown in the original article. I have no doubt whatever that this assumption is justified, and could advance a range or arguments to prove it, were space available. I do not see how the treatment put forward by Mr. Leigh can explain any but a limited number of the experimental results, and I invite him to extend it to cover even those which I have mentioned above. His argument that "it is impossible to get rid of the shunt capacity of one crystal by balancing it with the shunt capacity of the other crystal," and the sentences which follow in his letter, appear to me to be entirely unsound logic. Provided that the term "shunt capacity" is taken to include that of the holders, and balancing condenser if used, as it does in the equivalent circuit, then I deny his statement flatly. He goes on to say that it would be equally possible to balance out the series inductances. This is clearly untrue, since these equivalent inductances form part of a series resonator. They can thus only be treated as a part of this series resonator. The parallel capacities, on the other hand, form a separate path for alternating current. They can be treated separately if desired in an analysis. They can also be reached from outside the crystal and modified, such as by the addition of capacity in parallel. The case is thus entirely different.

The remainder of Mr. Leigh's letter calls for little comment. He quotes the recognised "textbook" requirements for a pass-band or an attenuating range, using them to show the possibilities of designing a filter confined by limitations far narrower than need be tolerated in practice. In his final criticism he again misquotes the original article, and states that the crystal has been wrongly described as inductive in a range where it is, in fact, capacitative. On the assumption that parallel capacities are balanced, a fact upon which the article relies, then the reactance of the series resonater which remains as the effective arm of the bridge is inductive, as stated.

In conclusion, I suggest to Mr. Leigh that the reactance curves which he has drawn represent only a part of the problem, and that if he reconsiders the matter more fully and reads the simple theoretical treatment without preconceived bias he may reach a modified conclusion.

I have every respect for the viewpoint of a fellow worker in this interesting field (which has been my especial study for more than seven years), and I look forward to any further views he may wish to publish.

E. L. GARDINER, B.Sc.(Lond.).

Northwood.

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### *Television Distribution*

IN a letter appearing in your issue of September 15th, Mr. L. Stapleton brings up the question of television distribution, from which it would be seen that the difficulties involved lie mainly in the supply to the transmitters.

There is something to be said for the points raised in the earlier part of the letter although it is only natural that full advantage should be taken of the "actuality" in the initial stage of television before programme technique has developed to the point where the subject can be enjoyed and the medium forgotten.

When, however, Mr. Stapleton goes on to suggest that a national system should be built up on recorded programmes, one wonders if he has really considered what this would mean. Even if we accept his assumption that radiation difficulties are relatively unimportant, would the use of film bring about the saving in cost to the B.B.C. and simplification of operation that he suggests? Under the arrangement which seems to be accepted at present the relaying is done by the Post Office and there is at least some possibility that the cost to the B.B.C. could be reduced by the use of the relay circuits for other purposes, whereas if the B.B.C. was to provide its own relay system in the form of film the whole cost would devolve on the corporation itself. Moreover, the actual cost of providing vision and sound projectors with scanning arrangements at all transmitters, coupled to the cost of film for fairly continuous operation, would not be small, while such a system would be cumbersome to work.

In view of the position of the B.B.C., financially and otherwise, it would seem best that it should confine itself to its proper function of broadcasting the material and leave the relaying to the Post Office. The B.B.C. engineers will be fully occupied in solving transmission difficulties without the addition of working a relay system. Although all reasonable steps should be taken to keep costs to a minimum, economy should not be carried so far as to seriously limit the scope of development, and if the prospects of broadcast television do not warrant a system which would do justice to the possibilities contained in this new science, before scaling down expense some consideration should be given to the possibility of revenue from other sources.

Mr. Stapleton's references to recording methods are rather puzzling. So far as I know, optical recording is the only one available. It would seem an impossibility to record images electrically in view of the high frequencies involved, though possibly, by speeding up the signal track sufficiently and using some variation of the diffraction light relay to maintain exposure, something might be done, though how to do this without unduly increasing film length and speed is impossible to say.

Hebden Bridge. J. BROADBENT.

# UNBIASED

## *Teleolfaction in Sight*

A GREAT many people have written to me during the past year stating that in view of the great progress of television they are surprised that no serious attempts have been made by scientists to tackle the sister problem of teleolfaction, or in other words, transmitting smell by wireless. Unfortunately, the problem is by no means an easy one. Sound and vision both consist of wave motion in the air and ether respectively, whereas smell consists of the actual transmission of particles of matter shot off by the thing which is creating the smell and impinging on certain nerve endings in the nose. It may be helpful if you all try to realise this great truth the next time that your nostrils are assailed by the emanations of an over-ripe cheese or other odiferous substance.

The air waves of sound striking the microphone and the ultra-short etheric waves of vision impinging on the iconoscope are readily converted to the relatively long waves of wireless and just as readily converted back to waves of the appropriate nature by the receiver. It has, however, not been found entirely impossible to convert into ether waves the solid particles of matter shot off by an odiferous substance.

Anybody can prove this by the simple experiment of standing a gorgonzola cheese in front of an ordinary microphone coupled in the usual way to a transmitter. The resultant bombardment of the microphone diaphragm by the gorgonzola particles will be found in most cases to result in vibrations having an amplitude exceeding that set up by a cathedral organ at a similar distance from the microphone. No method has been developed, however, of reconverting the transmitted ether waves back into smell.

This lack of success on the part of the scientists has been due to a failure to

An over-ripe cheese.

grasp the essentials of the problem. I have been working very hard on it in my laboratory and am, I am happy to say, in sight of my goal. My idea has nothing to do with that crude scheme of causing radio-actuated relays to release certain carefully bottled smells concealed in the receiving apparatus. No, my idea is far more fundamental than that, and in order to explain it, I must take you almost into the region of metaphysics.

I think that you all know that modern science inclines to the view that there are only two things in life, namely, etheric wave motion and electrons, all matter being composed of different combinations of the latter. The more advanced school of thought goes even further and believes that everything is merely a matter of etheric vibration. Without attempting to enter into an argument with either of them, I think I may say, without fear of being contradicted that, according to this theory, if we want to transmit cheese or any other substance instantaneously from London to New York it should only be necessary to send from the London transmitter the correct waveform and the result would be that at the New York end the

By
FREE GRID

aforementioned waveform would so mould the electrons that they would constitute cheese or whatever was being sent.

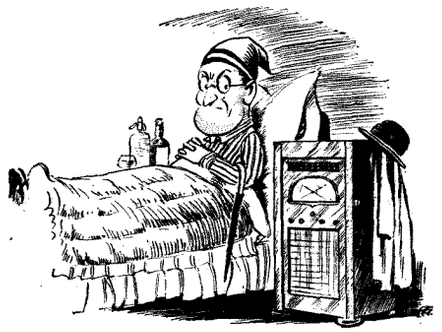
This may sound advanced and a little over the heads of some of you, especially those of you who have only just joined up with this journal as new readers, but I assure you that it is true. The solution of this great problem is in fact imminent, and it only remains for the purely electrical and other details to be worked out, but, needless to say, I shall leave such sordid trifles to our manufacturers.

## *Jazz or Jeremiads*

A KIND-HEARTED reader in far away Chattoonga, Tennessee, has sent me a cutting from his local newspaper in order to show me how much farther his countrymen have advanced along the road of scientific progress than we have. When I read his letter I turned eagerly to the newspaper cutting he sent me in order that I might add to my store of knowledge and wisdom, a thing which I am always anxious to do, as, in my opinion, it is the only justification for the continued existence of the human race.

I am sorry to say that I was bitterly disappointed, as all this so-called leader of science has done is to equip his house with a very ordinary PA system so that he can converse from the comfort of his bed with anybody knocking at the front door. In addition, he has installed a series of thermostats which open or close the windows in accordance with the prevailing temperature and, in very hot weather, automatically switch on an electric fan. It is this last bit about the fan which, to my mind, seems so utterly anachronistic. To think that in the land of air-conditioning and hot air the old-fashioned electric fan should have to be used.

I may say straightaway that my own household installation leaves this miles behind. I will only deal here with the purely wireless part of it. Needless to



Listening in comfort.

say, a complete push button set is at my side but not with the already old-fashioned idea of having the buttons labelled with station names. On the contrary, each button is labelled with a different type of music or other form of moral uplift, such as jazz or jeremiads. It is left to the set to search round the ether for the particular type of programme I want, and if there doesn't happen to be one on the air at the moment, an appropriate gramophone rendering is put on by an automatic record selector.

## *A Psychological Error*

THE B.B.C. make a great mistake, I think, in allowing details to be published of the very necessary wangles they have to carry out at certain times in order to make the television programmes realistic. I refer particularly to the recent revelation that a number of rats, which were due to appear in a television play, were actually filmed the previous day, the film being superimposed by the control room on the actual play. It only makes people unnecessarily suspicious.

In the case of the theatre, even though we all know that the very realistic-looking trees in a woodland scene are very far from being the real and solid things they appear to be, theatre managers do not go out of their way to explain that they are only made of cardboard or something like that. It is the same in other spheres of life. No doctor, for instance, deliberately draws attention to the fact that half his concoctions are merely coloured water; he knows that it would only have the effect of destroying his patient's faith in him.

Why should the B.B.C. make this foolish and very elementary error regarding human psychology? Surely they ought to have had enough experience by now. Personally, I have never felt quite the same about even the ordinary broadcast programmes since it was revealed that the sound of Niagara was produced by one of the engineers gargling.

# NEWS OF THE WEEK

## DUNDEE TO THE CAPE

### Radio on "Mercury's" Big Flight

DURING the 6,045-mile non-stop flight of the Mayo composite aircraft from Dundee to Cape Town, which was carried out between 1.20 p.m. on October 6th and 7.25 a.m. on October 8th, radio was an essential factor which contributed to the safety and success of the achievement.

Imperial Airways' First Officer, thirty-two-year-old Isaac Harvey, who accompanied Captain Bennett on the record-breaking flight, is probably the only officer in the organisation who has joined the company twice, first as a wireless operator, and then as a pilot.

#### *Wavelengths*

Wavelengths used by each station along *Mercury's* course vary considerably, and it was arranged that each group of stations should be notified by telegraph of her approach so that a definite prearranged wavelength could be used for the crew to take bearings and receive weather information.

In England and France the existing organisations were at the disposal of *Mercury*, and over the Sahara Desert a number of short-wave stations, mostly at military posts, were brought into service. Passing south, the route then crossed Imperial Airways' regular trans-African line and communication was established with Fort Lamy (just over the Nigeria-Cameroons border) and Maiduguri and Kano in the northern provinces of Nigeria.

The first coastal station to be picked up was Duala, in the French Cameroons, and from then on as far as the Belgian Congo ship stations were available as well as the aircraft stations used by the French and Belgian weekly services which operate down the West African Coast.

For the 900 miles of the route in the Portuguese West African area there were seven stations along the coast, and over South-West Africa Walvis Bay was an obvious station. Thereafter the excellent wireless facilities provided for South African Airways' Kimberley-Upington-Keetmanshoop - Mariental - Windhoek services were available.

#### *"Mercury's" Equipment*

*Mercury* is equipped with a combined short- and medium-wave transmitter developed by Marconi, and it is continuously adjustable for wavelengths from 15 to 200 metres in five ranges and from 550 to 1,100 metres in one range.

The machine carries two receivers, one for short, intermediate and medium waves and one for medium-wave direction finding. There is also a visual indicator attachment for homing. Direction-finding circuits are also provided on the upper medium-waveband on the first receiver thus giving an alternative direction-finding channel.

## CZECHOSLOVAKIAN BROADCASTING

THE Moravska-Ostrava broadcasting transmitter, together with its exclusive wavelength of 249.2 metres, became German property on October 10th, it being in the ceded territory. It now relays the Breslau programmes. The town of Moravska-Ostrava, in which are the studios of the station, will, however, remain in Czechoslovakia.

German official circles believe that they have a full right to this station's wavelength as it was only upon Czechoslovakia's claim for an exclusive wavelength for its German population that it was granted at the Lucerne Conference.

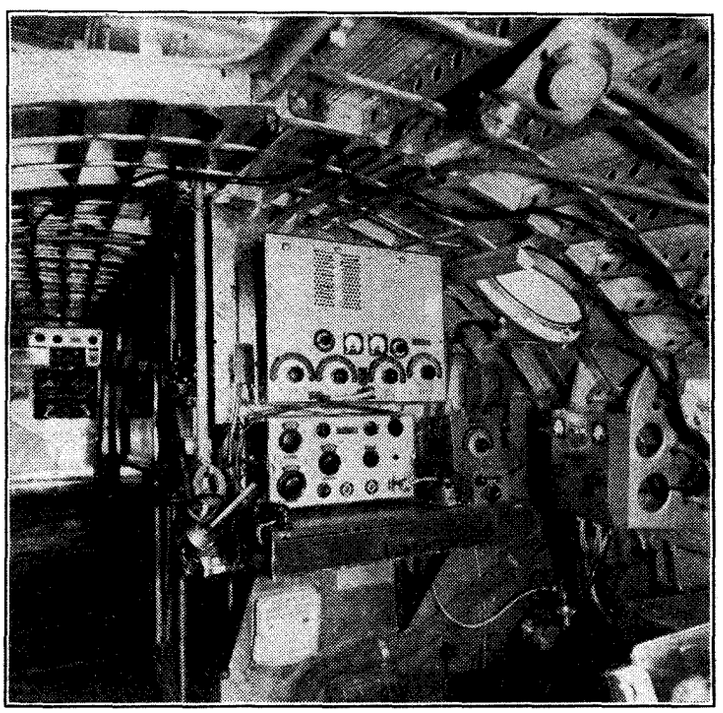
## FIRST TWO-STUDIO TELEVISION

### High-Speed Drama Production

ALTHOUGH the re-equipped Studio B at Alexandra Palace comes into commission for the first time this week, it will not be used in conjunction with Studio A for a single presentation until Sunday, October 30, when a "super" production of Rostand's "Cyrano de Bergerac" will be presented with Leslie Banks playing the name part.

For the first time the new central control room will be linking the outputs of seven camera channels, in addition to telecine. Two producers' control galleries will also be in operation—one in each studio—and the producer, George More O'Ferrall, will go to and fro between each during the course of production.

The rapid changes of scene necessary to maintain the speed and excitement of the action of the play, have, until now, presented insuperable difficulties for television. Without doubt it is the most ambitious studio presentation yet attempted at Alexandra Palace, and upon its success may depend the development of television drama in the next few months.



TYPICAL LAYOUT of Marconi wireless equipment aboard an Imperial Airways flying boat. The picture is dominated in the foreground by the aircraft transmitter and the receiver. A very similar installation is fitted in the "Mercury," whose smaller dimensions necessitated different disposal of the component parts.

## RADIO ALTIMETER

### A Device for Showing Earth Clearance

WHAT is claimed to be the first altimeter to show the earth clearance and not just height above sea level has been successfully tested by United Airlines of America.

The apparatus operates on an ultra-high frequency, the signal, transmitted from one wing of the 'plane, being reflected from the earth's surface and picked up by a receiver on the other wing. The elapsed time between transmission and reception is measured, and gives a direct reading in feet of the 'plane's height above the earth.

It is claimed that because of the use of the high frequency of 500 Mc/s the device is entirely free from atmospheric interference.

The apparatus, which will, it is understood, be fitted to all passenger 'planes of United Airlines, can be fitted with a signal light which will automatically flash a warning when the 'plane descends below a safety limit.

## NAPLES WAVELENGTH CHANGES

FROM to-day (October 20th) the wavelengths used by the two Naples stations will be changed. The 10-kW Naples I transmitter which at present works on 271.7 metres will now use 230.2 metres, which it will share with the Danzig 0.5-kW transmitter.

This change has been found necessary because of the interference caused by the 25-kW Latvian station of Kuldiga, which shared the same wavelength. The change has necessitated the 1-kW Naples II transmitter moving from 222.6 to 209.9 metres as it would otherwise be too near the frequency of Naples I.

## CORDIAL RELATIONS

AT the luncheon which preceded the opening of the North London Exhibition at Alexandra Palace last week, Mr. E. A. Cawdron, chairman of the Alexandra Palace Trust, said that the B.B.C. had taken a considerable portion of the space for television and it was quite likely that soon it would take more. If all went well, in a few years it would probably occupy the whole of the East Wing. That would mean that the Corporation would take over the Concert Hall and the Exhibition Hall. Relations between the Alexandra Palace Trust and the B.B.C.

**News of the Week—**
were most cordial and nothing would be done by either side to jeopardise the Exhibition.

### MR. OGILVIE LOOKS AROUND

THE B.B.C.'s new Director-General is losing no time in establishing the friendliest contacts with his staff, beginning by taking tea with the "key men" in each department and getting to know a good deal about the work of each.

In manner rather diffident, his conversation shows great erudition, though perhaps he is a better listener than talker. He gives the impression of immense reserves of mental and physical strength. The feeling in Broadcasting House is that Mr. Ogilvie will rule with kindness.

### WIRELESS FOR THE BLIND

IT is recorded in the Annual Report 1937-38 of the National Institute for the Blind, which has just been issued, that 6,000 loud-speaker sets and relay installations were issued through the British "Wireless for the Blind" fund during the year under review. This makes the total number of sets supplied since the fund's inception in 1929 36,500, of which more than 18,000 are still headphone receivers.

The library of talking books now consists of 183 titles. These books consist of 12-inch discs on each side of which, by a special slow-recording method, 25 minutes of reading matter is recorded.

### A HARDY ANNUAL

THE appearance of *The Wireless World* Diary for 1939 reminds us that Christmas and the New Year are not very far away. Apart from the actual diary section, this handy little volume is packed with data of great value both to the amateur and to those professionally engaged in the wireless industry. A certain amount of the data consists, therefore, of familiar formulæ and other information which everyone ought to remember but seldom does. A considerable amount of new matter has been introduced and some of the familiar features (including comprehensive valve data) have been presented in a new form.

The section devoted to circuit diagrams has been carefully revised, and the frequency, wavelength and power of all medium- and long-wave European stations and of all the more important short-wave stations of the world are given, together with special information concerning the amateur bands. Other information given, concerns decibels, phons, calculation of output transformer ratios, amplifier design, Q and RST codes, and a number of other things not usually available in compact and easily digestible form.

The diary, which is of convenient pocket size, may be obtained from Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1, price 2s. 6d. or 1s. 8d. post free.

### SNAPPY REPORTING

THE split-second speed with which the people of America were kept informed of the latest developments in the European crisis was demonstrated when the French Premier broadcast his acceptance of the invitation to attend the Four-Power conference. At the *same time* as he was on the air an N.B.C. announcer interpolated a translation of each sentence of the message. An example to the broadcasting authorities of the world.

### HOW MANY WATTS?

THE Electric Eel, which made its appearance at the Exide stand at Radiolympia, was again in evidence at the luncheon (but not on the menu) given by his owners at the opening of the Motor Show. The eel really does generate electrical energy, but only when angry or hungry. The voltage, however, is quite sufficient to light a neon lamp, but the ampere-hour capacity is small.

As an example of the latent power of a car battery, a demonstration was staged in which guests were invited to try their strength by turning a handle coupled through a brake drum to a pointer moving over a scale. Very few people managed to get the pointer to traverse more than half the scale in the time limit of ten seconds, whereas in the same period a car battery moved it over the whole scale.

### ANNOUNCERS' "HOWLERS"

SOME interesting howlers and Spoonerisms of B.B.C. announcers, which have recently been collected, show the human side of these exponents of correctness. When describing changes in the equipment of London's mobile police the announcer said, "Arrangements have been made for the London police to change their combinations this winter." A classic Spoonerism was, "You have just heard the Bathroom Orchestra from Pump," whilst another, describing a volcanic eruption, stated that, "A large area of lager is rapidly overcoming the village."

### AN OLD FRIEND RETIRES

THE retirement of Mr. Joseph Lewis, B.B.C. Assistant Director of Music, on November 23rd, will terminate a long period of service in the cause of music, He joined the staff at 5IT, Birmingham, in 1923, and since that time has broadcast on more than 4,600 occasions. He will conduct a farewell concert under the title of "My Music" on the day following his retirement. His successor has not yet been chosen.

## *FROM ALL QUARTERS*

#### Nearing Nine Million

THE total number of wireless licences in force in Great Britain at the end of September was 8,758,050. This shows an increase of 278,450 during the first nine months of the year. Even if the same number of licences (132,360) as were issued during the last quarter of 1937 are issued in the next three months, and this is very doubtful, the nine-million mark will not be reached this year.

#### New Orkney Transmitter

GM3TR is the call sign of the first amateur radio transmitting station to be authorised in the Orkney Islands. The operator is Mr. J. C. Graham, the Air Ministry air traffic control officer at Kirkwall Airport.

#### U.I.R. Wavelength Conference

THE meeting of the U.I.R. to formulate a European wavelength plan, for presentation at the European Conference to be held in Switzerland in February, which was postponed from October 3rd owing to the crisis, will now be held on November 7th.

#### Prepared for Shocks

ANTI-EARTHQUAKE measures have been taken at the new C.B.S. station at Torrance, California. The transmitter house has been built of reinforced concrete in two units to withstand high intensity earth tremors, both horizontal and vertical. Telephone lines between studio and transmitter are in duplicate.

#### Television in Italy

PROVISION is made for television development in the plans for Italy's new Broadcasting House in the Corso Sempione, Milan. In addition to sixty rooms devoted to apparatus and programme control, there will be three groups of studios and a space set apart for visual broadcasts.

#### Berlin Television

AN official announcement dated October 8th states that owing to the German Post Office having been overwhelmed with more important work for the State at this time, the opening of Germany's first 441-line public television service in Berlin, which had been planned for October 1st, was postponed indefinitely. One-hour experimental transmissions of film excerpts on 441 lines and repeated for another hour on 180 lines will continue.

#### Short Waves from Turkey

THREE new broadcasting stations at Ankara may soon be audible in this country. Two, on short waves, are TAP and TAQ, with wavelengths of 31.70 and 19.74 metres respectively. A 120-kW transmitter on 1,639 metres is also coming into operation with the others on October 29th, the fifteenth anniversary of the foundation of the Turkish Republic.

#### W.T. Apparatus Duty

UNTIL October 8th it was an offence to take any wireless apparatus into the Irish Free State without paying duty. An Order, No. 160, issued by the Finance Ministry now makes it possible for the Customs officials to grant a duty-free licence for wireless telegraphy apparatus to applicants. This Order does not, however, apply to ordinary broadcast receivers or associated components.

#### Mr. Churchill's Broadcast

WHEN Mr. Winston Churchill broadcast his reply to Herr Hitler's allegedly defamatory statements at Saar he spoke from a B.B.C. studio, and the speech was relayed exclusively through the networks of the National Broadcasting Company. This reciprocation of relay facilities is part of a standing arrangement which is frequently called into service on both sides of the Atlantic.

#### Olympic Games Broadcasts

BROADCASTING arrangements in connection with the forthcoming Olympic Games in Finland will cost about 13 million Finnish marks. The Suomen Yleisradio (Finnish State broadcasting organisation) has asked the Government to contribute a modest 10 millions towards this sum, which, incidentally, has to cover the purchase of a considerable quantity of additional apparatus. Foreign broadcasting authorities will bear their own relay expenses.

#### Confiscated Set to be Sold

THE first receiver to be confiscated by the G.P.O., the £63 radiogram of an unlicensed listener in Ipswich, is to be sold by order of the Ipswich Bench and the money realised to be paid to the Exchequer. The G.P.O. has on more than one occasion confiscated transmitters; these, however, are not usually sold, but dismantled.

#### German People's Set

THE 22,242 People's Receivers which were referred to last week as issued by the Goebbels-Rundfunke-Spende Institute bear no relation to the number which have been sold through ordinary channels; the production figures actually exceed three million.

#### Institution of Mechanical Engineers

SIR NOEL ASHBRIDGE, B.B.C. Chief Engineer, will deliver the 25th Thomas Hawksley Lecture at the Institution, Storey's Gate, London, S.W.1, on Friday, November 4th, at 6 p.m. His subject will be "The Development of Television."

#### I.E.E. Wireless Section

MR. A. J. GILL, B.Sc. (Eng.), Chairman of the I.E.E. Wireless Section, will deliver the inaugural address at the meeting on Wednesday, November 2nd, at 6 p.m.

# Random Radiations

By "DIALLIST"

## The Moth Problem

YOU may remember a discussion in these notes not long ago about the possible effects of a radio field on the direction-finding qualities of certain moths. Male moths of certain species will come very quickly from distances of several miles to a gauze or a muslin cage containing a lady moth of their own kind. It is generally held that they are guided by scent and the fact that they will sometimes come to an empty cage after the female has been removed from it seems to confirm this view. But there's also the possibility that radiation of some kind may play a part, and I have been trying to find out whether any operators, amateur or professional, have tried the experiment of putting, say, a female Oak Eggar into a cage hung close to a radiating aerial. So far I haven't been successful in my quest, though one or two readers have promised to make the experiment next summer when the Oak Eggar season returns. Meanwhile, I have a letter from a Warrington reader who recalls hearing his Professor of Natural History mention an instance which may have some bearing on the matter. Moths of one kind were found to collect in masses around the aerial of a ship anchored off Cape Town whilst transmission was going on. I have written to the Professor and I hope that he will let us have some particulars.

## Red-hot News

IT'S a queer thing, but, as I pointed out last week, you can often get news of happenings on this side of the Atlantic much earlier from American stations than from our own bulletins. Here is another example. A few days ago I tuned in one of the National Broadcasting Company's short wave stations about half an hour before the third news bulletin was due from the home Nationals. Between two items there came a news flash: "We have just heard," said the announcer, "that there has been serious rioting in Vienna, with which the police so far have not been able to cope." He then told us about the destruction of property by the mob, which had got completely out of hand. There wasn't a mention of the affair when our own news bulletin came along, and friends who had heard the American statement were inclined to scoff and to say, "Oh! Just another of those baseless rumours." But it wasn't baseless and it wasn't a rumour, as the headlines in the next morning's papers showed.

## Too Many Horrors

Speaking of news bulletins, I wonder if I may venture to offer the B.B.C. a word of friendly criticism? I have long been puzzled by their apparent partiality for horrors. Possibly you've noticed how much of some of the bulletins consist of accounts of how people were injured or lost their lives by accidents or mishaps of one kind or another. That sort of thing is news of a kind, but I don't think it's the kind that is particularly suited to broadcast bulletins or very welcome to the majority of listeners. And so many of the fatalities featured by the B.B.C. are of the sort that obtain only the briefest of mentions in the reputable newspapers. May we, please, have fewer horrors and more of the things that really matter?

## Some Panicked

ASTONISHING — isn't it? — to what lengths jumpy people will go in critical times in order to try to ensure that their own comfort shan't suffer. During the period of uncertainty and anxiety nervy folk all over the country were seized with the idea that they had better take precautions just in case supplies of electricity from the mains were cut off and batteries became hard to come by. The results were astonishing, and there was such a run on high-tension batteries that many dealers were sold out, and even manufacturers couldn't meet demands. Flashlamp refills were bought by the gross and high-tension batteries by the dozen. Presumably those who purchased HTBs in bulk had never heard of such a thing as shelf deterioration. They imagined that if they bought a dozen they'd be certain of their plate current for a year or two. They wouldn't, of course; various factors are at work which cause dry batteries to "run down" in time even when they're lying idle. Many dealers reported that when the crisis was over listeners who had laid in panic stocks wanted to return them and get their money back. Heads I win, tails you lose?

## A Good Crop

HOW many different kinds of television receiver would you say, off hand, were now on the market? If you had asked me before I turned up the latest list I'd have answered thirty or so, and that's probably somewhere near your own guess. A recent issue of *The Wireless Trader* shows that eighteen firms are making televisors, and that between them they produce the astonishing total of fifty-six different types! These range in price from 21 guineas for the little Pye set, which works in conjunction with an AC mains radio receiver, to £131 5s. for the Baird-Bush television receiver-cum-automatic record-change radiogram, £138 12s. for a similar instrument by R.G.D., and £173 5s. for another by Dynatron.

## All Sizes Available

The lowest number of valves is 12, in the Pye already mentioned, as well as in three of the smallest Baird-Bush sets; the highest number is the 40 of the big R.G.D. instrument. Intending purchasers can't complain that they haven't plenty of choice in almost every way. If you are content with a small image there's an Invicta with a $4 \times 3\frac{3}{8}$-inch picture; on the other hand, if you want the biggest, either G.E.C. or Baird-Bush will supply one with a $13\frac{1}{2} \times 11$-inch picture. Between these limits there are all kinds of sizes. Murphy, for example, can give you a $7\frac{1}{2} \times 6$, Cossor $8\frac{1}{4} \times 6\frac{1}{2}$; Murphy, again, $9 \times 7$; nearly every maker in the list $10 \times 8$, and Cossor $12 \times 9\frac{1}{2}$. Considering what they do, the wattage requirements of television receivers are remarkably modest. The small sets by Invicta and Pye are rated at 110 watts apiece, the Beethoven at 120, and most of the others between 150 and 200. Even the big-image radiograms mostly need no more than 210 watts.

## A Diversity Receiver

IT'S interesting to see that one of the big American firms has now produced a diversity receiver for home use on the short waves. The set itself is a huge affair, and I imagine that the price is correspondingly large; but it must be a jolly thing to play with. In some diversity systems identical signals are received on two different wavelengths, only the stronger at any given moment being passed on to the audio-frequency stages. This model can presumably be used in that way if you can find two stations relaying the same items. But even if you can't, there is often much less fading if you receive the same station on two different aerials, there being, of course, separate high-frequency mixer and intermediate-frequency stages for each. The makers say that a signal rarely fades at exactly the same instant on two aerials even if they are not very far apart. I imagine that diversity reception of one and the same signal in this way would be much more effective if fading was quick rather than fairly slow, and that it probably wouldn't be of very much use for dealing with really slow, deep fading.

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# The Wireless Industry

A USEFUL pamphlet about aerials, written mainly from the anti-interference point of view, is issued by Belling and Lee, Cambridge Arterial Road, Enfield, Middx. Free copies of the pamphlet, which is entitled "All About the Skyrod Aerial System," will be sent to readers.

Clix "Safeways" adaptors, suitable for the temporary connection of a mains-fed broadcast receiver to a lighting point, as well as for many other purposes, are described in a pamphlet issued by British Mechanical Productions, Ltd., 79a, Rochester Row, London, S.W.1.

The history, aims and business methods of the firm of Alfred Imhof, Ltd., are set forth in an eminently readable and attractive manner in a booklet entitled "This Year of Radio." The Imhof "Free Voucher Service Plan" (which offers special attractions to set buyers and on which we had occasion to comment favourably at its inauguration) is described, and an accompanying chart of receivers and television sets in order of price is a useful feature. Free copies will be sent to readers: Address, 112-116, New Oxford Street, London, W.C.1.

An exceptionally informative catalogue giving technical data on miniature ball bearings has been issued by Miniature Bearings, Ltd., 2-3, Duke Street, St. James's, London, S.W.1.

The Annual Ball of the Electrical Industries Benevolent Association is to be held on November 22nd, at Grosvenor House, Park Lane, London, W. Tickets (25s. each) from the E.I.B.A., 6, Southampton Street, Holborn, London, W.C.1.

Grampian dance band equipment is described in a leaflet available from Grampian Reproducers, Ltd., Kew Gardens, Surrey.

Details of the various Avo measuring instruments are given in concise form in a folder issued by the Automatic Coil Winder and Electrical Equipment Co., Ltd., Douglas Street, London, S.W.1. The firm will gladly send copies to readers.

# Waves

## THE FOUNDATIONS OF ALL RADIO

By "CATHODE RAY"

LOOKING around Radiolympia (if that isn't too much like ancient history) I seemed to be for ever coming up against cathode-ray screens with waves on them. I am not referring to the synthetic products of the hairdresser gleaming under the television studio lighting, but rather to those obtained by the earlier or legitimate employment of the cathode-ray tube for examining the workings of apparatus. These cathode-ray instruments, for the use chiefly of servicemen, usually display simple waves, which one is expected to greet with as hearty a cry of recognition as if they were Leonard Henry on the screen. It has occurred to me that the meaning of these waves may not be so obvious to everybody as that of the activities in the television studio apparently is. Briefly, why is a wave?

Of recent weeks this page has been getting almost indistinguishable from the writings of the learned savants who compose the rest of *The Wireless World*, but this time I want to return to the beginner. I issue this warning in case certain readers are expecting a dissertation on the inner meaning of the phon.

Waves, then. By the non-technical they are generally associated with the sea. But the sort that are seen at the seaside, however delightful a picture they may make, are not good samples for illustrating radio phenomena. And it is not everybody even of this maritime nation who has been out on the open ocean; and fewer still who, in that situation, have felt inclined to make a close study of wave movements. Though television fans will probably disagree, the waves one sees on non-television cathode-ray screens and in diagrams are also pictures. They are representations of something that cannot itself be seen. The cone of a loud speaker can be felt to vibrate; and in a sense the vibration can be seen if it is big enough, but not clearly, because the eye cannot follow things that are happening 30 or more times per second. The movements of electricity in coils, valves, and other parts, causing the loud speaker cone movements, are of course quite invisible, however violent they may be. The current movements in the forward part of the set are still further from affecting any human sense, because besides being extremely small they occur in incredible numbers per second. The state of things in the space between the distant transmitter and the receiver corresponds with the electric current movements, but apparently it is not even within reach of human imagination. Scientists are still arguing whether or not there is an "ether" for these waves to wave in.

One thing common to all these things, and hence to the whole basis of radio, is a movement that would commonly be described as vibration. Now if you take a pencil and draw a picture of a vibration, by making the point vibrate across the paper, the result is simply a line. The only information it gives is the amplitude of the vibration. One cannot tell its frequency per second; nor whether it is a smooth or jerky type of movement.

One of these mornings with its chilly premonition of the onset of winter I shivered when I was parting my hair. The result was a picture of the shiver. What should have been a straight line actually had a wave in it. My hand shivered or vibrated, which alone would merely have produced a trifling movement from left to right, but combined with a steady movement from back to front it drew a wave, from which could be deduced not only the amplitude of the shiver, but also its form and its frequency. Actually one wave appeared in about an inch, and as I comb partings at the rate of several inches per second the frequency of the shiver must have been several per second. If my hand had been connected to the moving part of a loud speaker it would have drawn a large number of waves in the length of parting covered in a second. To show them on a more ample scale it would be necessary to increase the forward speed of the comb.

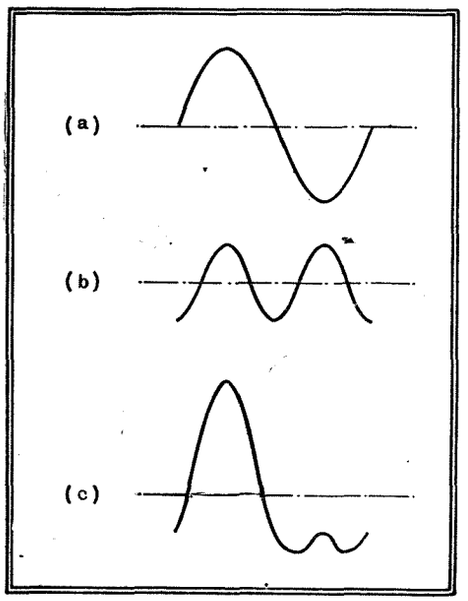



Fig. 2.—The waveform (c) is the result of adding together the two simple waves (a) and (b) and is equivalent to them. Any waveform, however complicated, can be analysed into simple waves.

A cathode-ray oscillograph or oscilloscope is an instrument for doing the same thing more conveniently and accurately. By connecting a source of voltage waves to the vertical pair of cathode-ray deflecting plates, the spot of light on the screen is waved up and down, and draws a straight line (Fig. 1(a)) showing the amplitude of the wave. If to the horizontal pair of plates is connected a voltage that keeps on repeating a steadily growing motion (corresponding to combing the hair) the line is drawn out into a wave. In this way it is possible to distinguish between waves like (b) and (c), which without the horizontal motion both look like (a); and to count the number occurring in the time of one horizontal stroke.

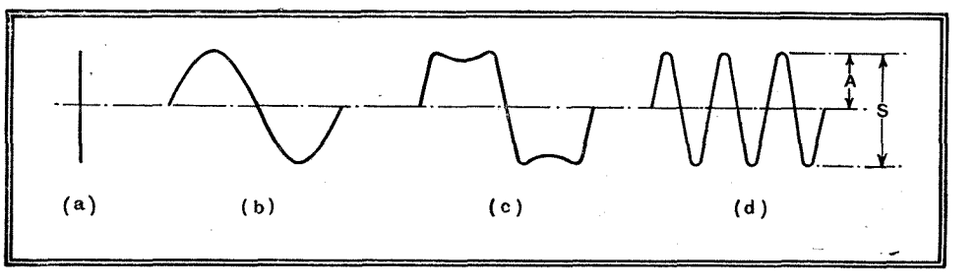



Fig. 1.—A vibration marked on paper produces only a line (a), which indicates nothing except the extent (or amplitude) of the vibration. By combining it with a steady movement at right angles the vibration is drawn out into a wave. In this way various forms of vibration can be distinguished, such as (b) and (c); and different frequencies, such as (b) and (d). As all "radio" is based on vibrations (or oscillations) of electricity, ether, magnetism, diaphragms, and air, the importance of this in examining its functioning is obvious.

### The Complete Cycle

At this point it may be a good thing to dispose of a misunderstanding that is not yet quite dead. Fig. 1(b) shows one wave, not two. Sometimes a rectifier that utilises only the upward half of this is called a "single-wave" rectifier, and one that uses the whole, a "double-wave" rectifier. These terms should be "half-wave" and "full-wave" respectively. Frequency is the number of whole waves per second. But the amplitude, or *peak value*, of a wave is the amplitude of one of the two halves of a wave, shown by A in Fig. 1. The two halves may have different amplitudes. The peak-to-peak measurement, marked S, is called the

**Waves—**

double-amplitude, or swing. Although there is not time just now to go into all the why and wherefore, I may just say in passing that the commonly used *RMS value* of a wave—by which, for example, our AC electricity is reckoned—is 0.707 times the peak value.

Amplitude and frequency are two of the three most important things about waves. The third is *form*. If the original form is altered, that is distortion. When anybody starts dealing with this subject he can be relied upon sooner or later to use the word *sine* or *sinusoidal*. This is just the simplest and purest form of wave, from which all others can be made up. If you look from some distance end-on to a steadily revolving wheel, any spot on it appears to move up and down, and if this movement were to be spread out in wave form it would be a sine wave. The pedals of a cyclist who is moving towards or away from you at uniform speed are seen to move up and down in this way. If he is slowing down the frequency of the wave decreases. And if he is pedalling jerkily the waveform when spread out would be seen to be different from the smooth symmetrical sine shape. So this is one way in which the cathode-ray tube can be used to detect distortion.

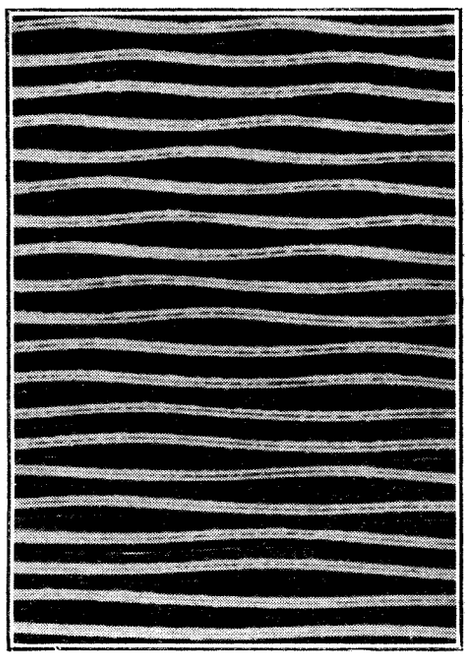
The electricity supplied to our houses (if AC) is a continuous succession of waves, and could be specified under the three headings we have just considered: for example:

Frequency: 50 per second.

Amplitude: 230 volts RMS, equal to 325 volts peak.

Form: as nearly as possible a sine wave, but some impurities usually present.

The last of these is taken for granted; the first two are briefly stated as 50-cycle 230-volt supply. (So the connection between the wireless man's cycles and the roadster sort is not so remote as the jokers imagine.)



Enlarged photograph of the grooves on a gramophone record

What I have said about sine waves hardly seems enough to account for the great importance and reverence in which this particular brand is held, especially by mathematicians. The vital fact is that all other sorts of wave can be built up from sine waves, just as all the endless variety of chemical substances can be built up from a comparatively small number of elements. Both are wonderful processes of Nature, and in a way the composition of waves is the more wonderful of the two because there is only one element—the sine wave—from which all others are built up.

People who drop in for a chat about the "marvels of wireless" nearly always say that the thing that beats them hollowest is how all sorts of complex sounds can come from a single groove on a gramophone record. Gramophone recording is an excellent example of what we have just been discussing. There is the vibration of the needle point across the record, and there is the uniform continuous motion at right angles, drawing the vibration out into a wave. When playing the record the process is reversed, the wave is converted back into a vibration which reproduces the original sound (or, in practice, something like it).

### One Channel: Many Waves

I don't know why it is that the complex music in a single groove strikes people as being more wonderful than the same thing in a single air space between the orchestra and the ear, or in a single wire between the set and the loud speaker. In every case there is only one "channel" of communication. Perhaps it is because they can see a gramophone record groove, whereas the other media are all rather unknown and mysterious, and therefore have greater potentialities for doing complicated things. However that may be, the same principles apply. The most complex sound, such as an orchestra of 115 instruments, with a group of soloists, and a chorus or two, together with morse from North Foreland, atmospherics from an approaching thunderstorm, interference from Toulouse, and buzzes from next door's vacuum cleaner, can be built up from sine waves. In other words, wave *form* is not an independent quality, but depends on the frequencies and amplitudes of the simple sine waves which are its ingredients. Actually there are two other qualities—phase and decrement—that have to be given in order to specify these ingredients completely, but I have just realised that there won't be enough space left to explain much about them. With *continuous* waves, such as our domestic electricity supply or the world-famous soprano's top note, decrement is non-existent and phase is unimportant, so far as the ear is concerned.

Some time ago I paid a visit to the factory where the B.B.C. Theatre and Concert Hall organs were built. It was about a minute to the hour when I arrived, and my technical friend who greeted me seized my arm and dragged me out into the road. "Listen!" he said. I listened. Soon familiar sonorous chimes floated forth from the tower of the factory. "Big Ben!" I said. "You have a good amplifier." "Yes," he replied. "We had to shut it down because of our neighbours. But it isn't Big Ben, and it isn't a record. I make it up from sine waves." And he took me in and showed me his apparatus for mixing a number of simple waves of any desired frequency and amplitude which are generated electrically and then mixed together to give the desired sound. I had visions of a possible Mrs. Beeton's book of the air: "Take the following sine waves, guaranteed pure; mix well and stir. Serve $2\frac{1}{2}$ watts for four persons," and so forth.

For bells it is necessary to have decrement or *dying away*, but for ordinary organ notes it is only necessary to mix together sine waves of appropriate frequencies in the correct proportions to reproduce the tone of fiddle, flute and euphonium, to say nothing of many instruments that were never heard at all in the Floral Dance.

Nature has very thoughtfully arranged that it is not necessary to deliver each of these ingredients separately. After all, we have only one pair of ears, and only one line of communication—air—between them and the world of sound; so if it is possible to hear a lot of sounds at once in the ordinary way, it is only to be expected that they can be safely entrusted to a single groove in a record. To take a very elementary example, Fig. 2(a) is a single sine wave, and (b) is another of twice the frequency and half the amplitude. It could be otherwise described as a 50 per cent. second harmonic. (c) is a mixture of the two, got by adding the amplitudes of (a) and (b) at every instant. It has quite a different form from (a) and (b) separately. Now if the form (c) is engraved on a record and played, the sound is absolutely indistinguishable from two records, carrying the pure tones (a) and (b) respectively, played simultaneously. There is no reason why they should be any different, for even if they are kept separate on the records or in the loud speakers, they mix immediately they become actual sounds in the air.

## STANDARD FREQUENCIES

ON Tuesday, Wednesday and Friday of each week, except legal holidays, the American National Bureau of Standards station, WWV, transmits signals for frequency calibration on a power of 20 kW. The schedule is as follows:—3 p.m. to 4.30 p.m. on 5,000 kc/s; 5 p.m. to 6.30 p.m., on 10,000 kc/s; and 7 p.m. to 8.30 p.m., on 20,000 kc/s (all times G.M.T.). The Tuesday and Friday transmissions are unmodulated CW except for one-second standard-time short-pulse signals at 1,000 c/s modulation.

On Wednesdays the carrier is modulated 30 per cent. at 1,000 c/s. The radio frequencies transmitted by WWV have an accuracy better than one part in five million.

# Recent Inventions

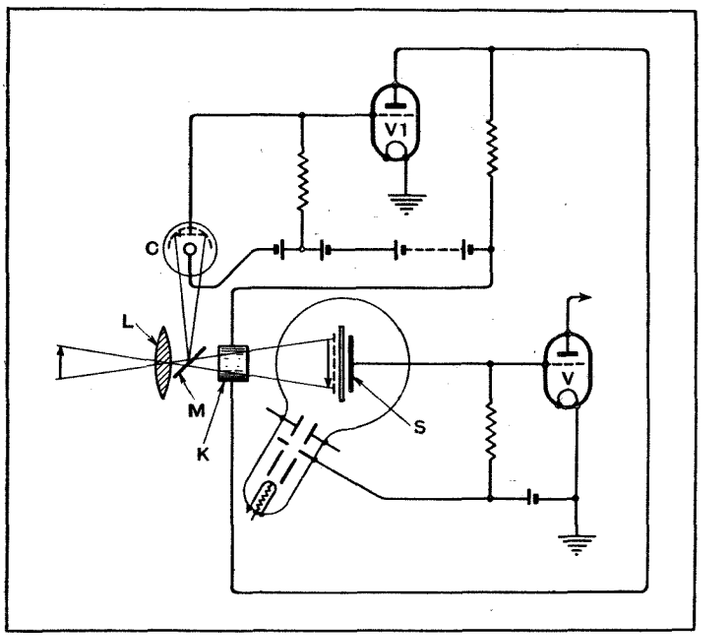
***Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.***

## TELEVISION SYSTEMS

OCCASIONALLY it may be desired to produce "dissolving" or "ghost" effects in television, for instance by superposing one scene upon another. Similarly it may be useful to display the name of the transmitting station now and again during the course of the programme, or to "insert" advertising or descriptive matter, without disturbing the actors in the studio. There are further possibilities in the use of certain "trick" effects, such as giving the impression that a scene is being transmitted under a spotlight, whereas, in fact, this is not so.

The invention is concerned with the production of such effects by feeding several different pictures into a common signal channel, and describes means for dissolving one or other of these at will, so as to change the pattern or composition of the final picture according to a predetermined plan.

*Marconi's Wireless Telegraph Co., Ltd. Convention date (U.S.A.), December 31st, 1935. No. 488268.*




**Increasing light intensity range in television transmission.**

THE variation of light intensity to be found in ordinary outdoor scenes is of the order of one to a million, and it is not possible, with the means at present available, to preserve these differences in television pictures. The sensitivity of the usual light-sensitive device is of the order one to a hundred, and this is fully utilised in maintaining the necessary "contrast" values in any given picture, without allowing for any changes that may occur from time to time in the average "background" illumination, say, as between a bright sunlit scene and one taken under a grey sky.

The difficulty is met, according to the invention, by deliberately cutting down the value of the mean light intensity that is allowed to fall on the photo-sensitive screen of the transmitter, thus leaving something in hand to follow changes in the average or background illumination.

As shown in the Figure, light from the scene to be televised is focused by a lens L on to the photo-sensitive screen S of a cathode-ray transmitter, the resulting picture signals being amplified by the output valve V. Interposed between the lens L and screen S is a semi-transparent mirror M, which diverts some of the original light on to an auxiliary photo-electric cell C. The reflected light, after being amplified by a valve V1 is used to control the effective transparency of a Kerr cell K, which then acts as a "shutter control" to moderate any excessive changes in the intensity of the original light.

*Radio-Akt. D. S. Loewe. Convention date (Germany), December 16th, 1935. No. 487240.*

## AUTOMATIC TUNING CONTROL

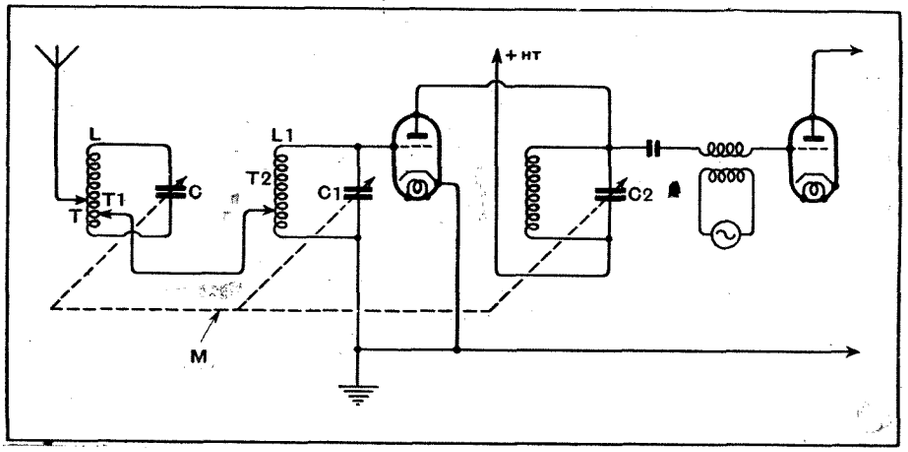
AUTOMATIC fine adjustment of a set that has initially been roughly tuned can be effected by a pair of supervisory circuits, one tuned slightly above and the other slightly below the fixed intermediate frequency. The arrangement produces a control current which is used to correct the original error.

According to the invention, the initial tuning of a superhet receiver is automatically "fined down" to the correct point by making use of the difference in phase between the currents set up in two supervisory circuits, both of which are tuned to the fixed intermediate frequency.

The method is based upon the fact that a 90 deg. phase-difference exists between the primary and secondary coils of a doubly tuned transformer when signal energy is applied to it, and upon the further fact that this phase-angle changes as the applied frequency is varied.

In this way a control current is derived from the phase-discriminating circuits, and is applied to adjust the frequency of the local oscillator valve until the true tuning point is reached.

*Marconi's Wireless Telegraph Co., Ltd. Convention date (U.S.A.), October 17th, 1935. No. 489094.*




**Rejector circuit designed to avoid attenuation of the desired signal.**

## RADIO NAVIGATION

AN aeroplane in flight can be navigated along a "guiding line" formed in the ether by beams sent out from a directional transmitter. Or it can "home" on to an ordinary beacon station which radiates equally in all directions, provided the craft is fitted with a directional receiving aerial. The most reliable receiving installation for this purpose consists of a frame aerial combined with a vertical aerial, the two together producing the so-called cardioid or heart-shaped response. If now the polarity of one or other of the two aerials is periodically reversed, the two heart-shaped curves will overlap and give a definite "homing" course.

The invention relates to a direction-finding installation of this kind, and is characterised by the use of two rectifiers to effect the required switching-over of the aerials. The rectifiers are alternately brought into and out of action by a locally applied voltage of rectangular or square-topped form, and so give a more clear-cut reversal than usual.

*N. V. Philips Gloeilampenfabrieken. Convention date (Holland), May 14th, 1936. No. 488021.*

## SUPERHET RECEIVERS

MANY schemes have been proposed for suppressing the so-called "image" frequencies in a superhet set. One is the use of a rejector circuit which is closely coupled to the aerial, and ganged to the main tuning control. This arrangement, however, tends to attenuate the desired signal, as well as the "image," owing to the voltage-drop across the closely coupled rejector.

The inventors describe an alternative arrangement which, it is claimed, effectively blocks out the image frequency, without attenuating the desired signal. It consists of a rejector circuit L, C which is connected in the aerial circuit as shown, and loosely coupled to the input circuit L1, C1, by the tappings T, T1, T2.

The rejector circuit is preferably "lightly" tuned, i.e., the inductance L should be small and the capacity C large, and the tuning condensers C, C1, and C2 are all ganged together by a connecting rod M.

*C. Lorenz Akt. Convention date, (Germany), August 12th, 1936. No. 488898.*

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*As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.*


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# *EDITORIAL COMMENT*

## Television Progress

### *Need for Trained Men*

*EVIDENCE* is accumulating to show that public interest in the television service has at last been aroused and in spite of the natural setback which the recent international crisis brought about, there has recently been a very brisk demand for demonstrations and sales of receivers are, we are told, exceeding the anticipations of the manufacturers. This being so, we must by now surely have reached the stage where there can be no question of turning back by the B.B.C., and however difficult the problems of finance may be, a solution will have to be found which will enable television to be carried on and developed energetically.

One of the problems which is bound to face the industry and influence materially the success of television development is that of servicing effectively the sets which are distributed amongst the public. We know that if the normal broadcast receiver has had its share of servicing troubles, it is natural to assume that however efficiently television sets are manufactured and tested before they leave the factory, they too will from time to time require some attention from an expert, particularly in view of their greater complexity.

Broadcast receivers are, for the most part, reasonably portable and in the event of failures they can be sent back to the manufacturer for repair, but the additional complexity and weight of the television set and the fact that its performance may be largely influenced by prevailing local conditions, means that it cannot conveniently be transported for overhaul or for some defect to be traced and put right. The servicing will, therefore, have to be done, no doubt, by a local representative. It is easy to appreciate that servicing a complicated piece of apparatus on the spot requires a much higher standard of knowledge and general competence on the part of the service engineer than is the case when apparatus is returned for servicing to the factory, where highly skilled engineers are at hand to supervise the work and where permanently installed test gear is available.

### *Get Ready Now*

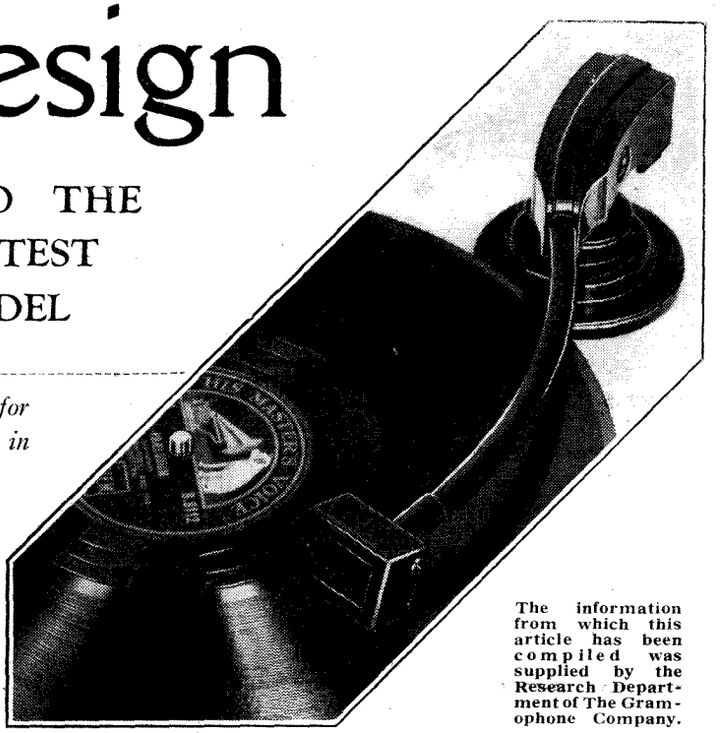
As and when the television service is extended to cover parts of the country outside the London area, the need will surely arise for trained local men capable of undertaking the installation and maintenance of receivers in the newly served localities.

The difficulty of obtaining men able to service television receivers competently is already being felt acutely in the London and Home Counties area. Those in other districts who are sufficiently optimistic about the future growth of television should begin to prepare themselves now for the time when the B.B.C. system is extended to cover their own neighbourhood, and when their technical services will consequently be required.

It is certainly not too soon to start to acquire the necessary knowledge. The receiver itself is a complicated instrument which no service engineer whose experience is limited to broadcast receivers in general can hope to deal with unless he has had preliminary training and experience. The installation too of television sets is a specialised job in itself, requiring an entirely new technique in the matter of aerial installation, as compared with that to which the service engineer is accustomed in connection with ordinary broadcast receivers.

# Pick-up Design

## CONSIDERATIONS LEADING TO THE DEVELOPMENT OF THE LATEST H.M.V. "HYPER-SENSITIVE" MODEL



The information from which this article has been compiled was supplied by the Research Department of The Gramophone Company.

*THE necessity for improvement in pick-up design has long been recognised. This article shows that the present performance of pick-ups is due to the mechanical system employed, and also shows that a much improved pick-up can be obtained by designing the mechanical system around a new type of needle.*

FOUR or five years ago gramophone pick-up performance reached a stage which has scarcely been improved upon to any marked degree. This lack of improvement is probably due to the standardisation of needles and of systems of armature and pole pieces, which influence frequency response, record and needle wear, and acoustic buzz.

The mechanical system of the usual moving iron pick-up is shown diagrammatically in Fig. 1. It will be seen to consist of the usual soft iron armature, hollowed out to take the needle, carrying a paddle-shaped extension piece, the upper portion of which is embedded in a pad of rubber. The pad of rubber fulfils the double purpose of holding the armature in the mid-position of the air gap against the magnetic pull of the pole pieces, and also providing damping for the vibrations of the armature. The armature is pivoted in the bottom portion of the pole pieces by thin rubber sleeves, which usually contribute a centring control assisting the rubber pad in locating the armature. Such a system, consisting of weights or masses anchored or held at rest by springy members, must have a number of resonant frequencies.

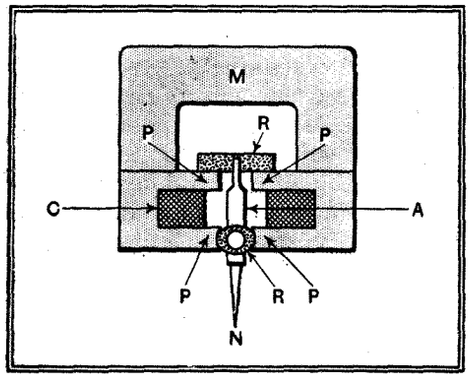



Fig. 1.—Section of the conventional "half-rocker" type of pick-up using standard needles. A, armature; N, needle; R, rubber centring and damping pads and sleeves; P, pole pieces; C, pick-up coil; M, permanent magnet.

The three important resonances of the system are found to be :—

(1) Low-frequency resonance due to the effective mass of the whole pick-up and arm coupling with the springiness of the armature suspension, causing a high mechanical impedance at the needle point.

(2) Medium-frequency resonance due to the effective mass of the vibrating armature and needle coupled with the springiness of its suspension, causing less important reactions at the needle point.

(3) High acoustic frequency resonance due to the effective mass of the vibrating armature and needle coupling with the springiness of the needle itself, causing a high mechanical impedance at the needle tip.

### Reducing Record Wear

It must be remembered that the needle tip is driven to and fro by the walls of the record groove, and it is evident that in order that the needle point may follow accurately the grooves in the record, the mechanical strength of the wall of the groove must be sufficient to offer a reaction to the needle point to overcome the lateral forces. If it cannot do this, it means that the wall of the groove is damaged and record wear takes place.

It is necessary therefore, in considering a new pick-up design, to work back from a comprehensive study of record groove shapes, needle tip forms, and the wearing away of both under specific circumstances, particularly to meet the conditions of high mechanical impedance mentioned in (1) and (3) above.

Measurements and calculations on a number of commercial pick-ups, needles and records now on the market have yielded interesting data, experience from which enabled a greatly improved pick-up to be designed. Most commercial pick-ups have an effective mass of the whole pick-up and arm of over 100 grams, and resonance (1) above is found to be about 40 c/s, while resonance (3) lies at about 3,500 c/s with a "loud tone" needle. Both these resonances are within the recorded range.

Commercial pick-ups of the type being considered and using rubber as a damping material have peaks in their electrical output at resonance (3) of considerable amplitude, depending on the amount of damping present. The use of additional damping, however, has the effect of stiffening up the armature suspension and increasing the frequency of resonance (1).

The maximum force likely to be encountered between needle tip and record groove wall is a little over $100 \times 10^3$ dynes. The record groove wall is inclined at approximately 45 deg. to the vertical, and therefore, to ensure accurate tracking, the weight on the needle point has to be at least equal to the force acting on the groove wall. This means that the weight on the needle point in the pick-ups under consideration has to be around 120 grams, and even so the tracking of notes of frequencies near to resonance (1) is rough, and considerable groove wear takes place.

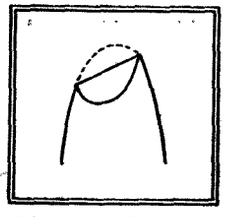


Fig. 2.—Enlarged side elevation of needle point showing wear.

Using a needle point as above, needles wear away and develop "flats" very rapidly (see Fig. 2). It will be appreciated that when the length of "flat" on the needle exceeds the quarter wavelength of a frequency on the record, that frequency will become attenuated in its transference from the record, owing to the fact that the needle point cannot accurately follow the wave. When the "flat" length approaches the half-wavelength, the attenuation of this frequency and those above it becomes con-

**Pick-up Design—**

siderable, and the needle point is excited by a series of bumps, which tends to send it into vibration at the natural resonance frequency of the system, that is, resonance (3). This accounts for the fact that a considerable output may be shown on a valve voltmeter at the high frequencies when using a badly worn needle.

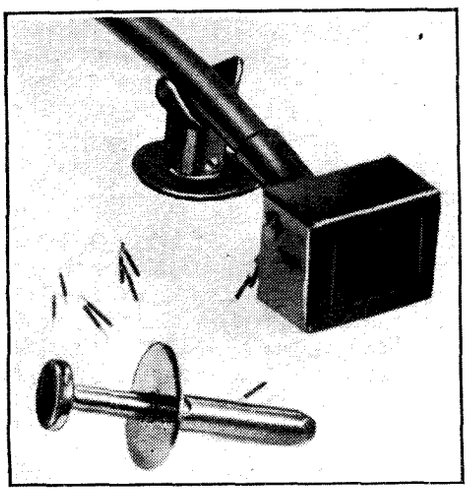
The attenuation of high frequencies due to needle "flat" will, of course, be most pronounced at the inside grooves of a record, and at this point a flat length of 0.002in. corresponds to a half-wavelength of 4,100 cycles per second. For good top response on the inside grooves of a record, therefore, the needle "flat" must not exceed 0.002in. On the majority of sets with limited output and therefore limited top response a "flat" of 0.004in. becomes tolerable.

## Effective Frequency Range

We have therefore the important fact that the effective frequency range of a pick-up is determined to a large extent by needle wear, which is dependent on the forces produced at the record groove by the mechanical constants of the pick-up system.

Record wear is the result of the inability of the record groove to withstand the pressure exerted on it by the needle point. It will therefore be dependent on the weight on the needle point, and can be said to be more or less proportional to needle wear.

The acoustic buzz which originates in the needle groove system is radiated strongly by the face of the record itself, and can be reduced only by changing the mechanical characteristics of the pick-up system, thus reducing the needle-groove reaction.



A special tool is provided for handling the miniature needles used in the H.M.V. "Hypersensitive" pick-up.

It will be seen, therefore, that the general performance of a pick-up is determined by the constants of the mechanical system of the pick-up. This will hold for crystal and moving coil types of pick-ups, as well as for the conventional moving iron type.

Our task, therefore, in producing an improved pick-up is so to proportion the mechanical system that the forces at the needle point are small, which will enable the weight on the needle point to be reduced and still maintain good tracking. Needle and record wear will be reduced, effective frequency response extended, and acoustic buzz minimised.

In the case of needle armature pick-ups, the armature has been reduced to practically nothing, and the needle itself constitutes the main effective mass, which has thus been reduced to about 25 per cent. of a normal armature, but the increased length of unclamped needle has an effect on its stiffness so that resonance (3) cannot be increased much above 6,000 c/s. In addition, the construction prevents the application of appreciable damping to the system so that the mechanical impedance, and therefore needle and record wear, etc., all become considerable at frequencies approaching 6,000 c/s.

With the improved type of pick-up about to be described it was decided to increase the frequency of resonance (3)

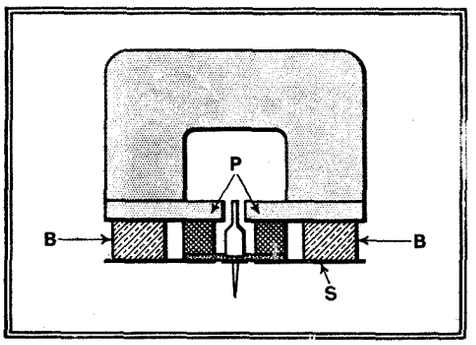
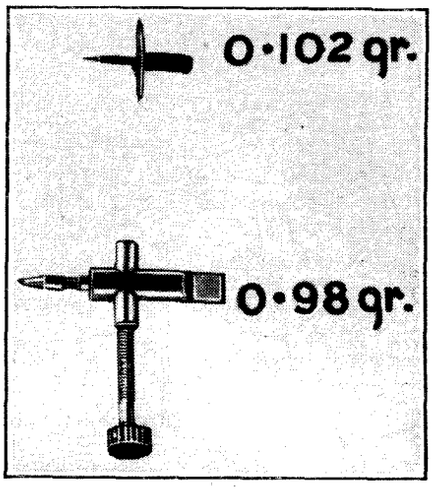



Fig. 3.—Section of redesigned pick-up. There is only one pair of pole pieces, P, and the coil is outside the main magnetic circuit. The armature is attached to a flexible steel strip, S, mounted on brass blocks, B.

to such a value as to remove it completely from the recorded range and a figure of 10,000-12,000 c/s was decided on. In order to achieve this it is not possible to use standard size needles, and a special miniature needle is necessary. In addition, the needle is not clamped in the armature, since a needle screw is not practicable with so small a system, and in any case is unnecessary, provided the mechanical impedance at the needle point is kept low over the recorded range of frequencies.

The consequent reduction of mass causes the needle point-groove force to become of the order of $10 \times 10^5$ dynes as compared with over $100 \times 10^5$ dynes for the ordinary commercial pick-up of to-day.

The suspension stiffness of a pick-up is decided generally by the rubber pad acting on the "fin" extension and fulfilling the double purpose of centring the armature and supplying damping to the vibrations of the armature. With pick-ups of the type shown in Fig. 1 the magnetic pull on the armature "fin" for any position off the mid position in the gap is very considerable and increases at a rapid rate as the "fin" approaches the pole pieces. The resistive force of the rubber pad, however, under compression increases at a linear rate, consequently the




Armatures of the new "reactionless" pick-up (top) and one of conventional design with comparative weights.

stiffness of the rubber under maximum compression has to be at least great enough to counteract the magnetic pull on the armature "fin" when it approaches the pole pieces, otherwise the armature would "freeze over."

One method of balancing this magnetic pull without incurring a high stiffness would have been to have used a non-linear stiffness device, that is, a system whose stiffness increases with deflection from the mid position. The method adopted, however, on this improved form of pick-up was to alter the system of pole pieces so that the increase in magnetic pull with displacement from the mid position is very small and occurs at approximately a uniform rate. The system used is shown in Fig. 3 and the alteration will be seen to involve simply the removal of the part of the pole pieces providing the return path for the flux variation which occurs when the armature is displaced. Consequently, the change in "DC" flux with armature displacement is limited by the change in magnetic permeance of the leakage paths, which is very small. The magnetic pull, therefore, is quite small and increases only slightly with armature deflection.

## Low-impedance Coil

It might be thought that removing the return path for the variation in "DC" flux would also remove it for the "AC" flux, but owing to the very slight penetration of "AC" flux in soft iron, particularly at the higher frequencies, the "AC" flux does not rely to a great extent on the soft iron return paths, but returns through air. There is a certain loss in output due to this, but it is compensated to some extent by the reduction of the coil impedance, particularly at the higher frequencies. This is of a distinct advantage in that the dimensions of the coil of the improved pick-up necessitate the use of a step-up transformer which operates very

**Pick-up Design—**

much better when fed from a coil of low reactance and more constant impedance. In addition, the system requires a smaller driving magnet to produce the working gap flux. By the use of this magnetic system the stiffness of pick-up suspension has been reduced, so that the resonance (1) is taken below the useful recorded range. The armature is suspended by a thin steel strip.

Fig. 4 gives the frequency response of the new design of pick-up and of a typical present-day commercial pick-up, as measured on a valve voltmeter, but it should be borne in mind that the value of such response curves is not very great unless some indication is given of the percentage harmonic present, which, as was pointed out earlier, is affected by the length of "flat" present on the needle point.

The output voltage of the improved pick-up, while not as great as that of the usual moving iron type, is ample for most two-stage amplifiers. It is possible by using a high ratio step-up transformer to obtain approximately 1 volt output, but the higher frequencies become attenuated particularly above 5,000 cycles.

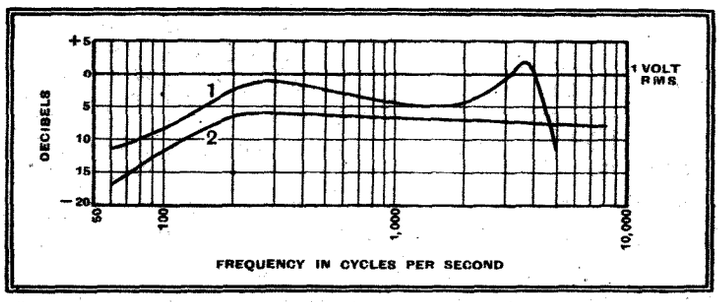



**Fig. 4.—Response curves of (1) typical conventional moving iron pick-up, (2) improved H.M.V. pick-up. In each case the measurements were taken with a 100,000-ohm shunt.**

The resulting pick-up is found to be remarkably free from acoustic buzz, and to cause record and needle wear in such small degree as to be practically negligible, and it has been truly described as "reactionless."

# Amateur Transmitters

## OUR LICENSING SYSTEM NEEDS DRASTIC REVISION

By "ETHERIS"

THE leading article in *The Wireless World* of October 13th on the licensing of amateur transmitters sums up the feelings of probably 90 per cent. of Great Britain's "hams" to-day. There has long been a conviction in those places where amateurs foregather that the present system of licensing is in many ways anomalous.

In its dealings with amateurs the General Post Office is always careful to point out that it issues "experimental transmitting permits," and not permits for general communication. No private person can obtain a transmitting licence unless he furnishes adequate and convincing data on the experiments he wishes to conduct. On receiving his licence he promptly forgets all the high-flown experiments he adduced as an excuse for wanting it, and settles down to a life of enjoyable communication with his fellow "hams." Nor does the G.P.O. require him to submit periodical reports on the results of his experiments (which would at least be consistent), thereby tacitly admitting that it doesn't really care whether he experiments or not!

Why, then, this farcical insistence on "experimental" transmission? There are two reasons: (1) Because it is the law of the land that all communications are vested in the Government, or leased by them to corporate bodies; (2) it is equally the law that no hindrance must be placed on individuals wishing to use the communal ether. But since the latter conception clashes with the Governmental monopoly there is only one thing to do and that is to grant licences, not for communication purposes, but on experimental grounds.

The whole "experimental" business is a farce for another reason. Amateur experimenters have seldom the resources or the knowledge for doing radio research work of the type carried out by the great companies and professional laboratories of this country. As an example may be quoted the amateur transmitting experiments on the ultra-short waves of 5 metres and below, which to the writer seem rather pathetic. Amateurs are stumbling along in a territory where regular commercial services have been established for some years. Particularly anomalous is the fact that the G.P.O. itself, while issuing 5-metre experimental permits with one hand is with the other hand operating regular public telephone services around this wavelength! They wouldn't do that if they hadn't found out pretty well everything there is to be found out there.

There seems to be a strong case, then, for a drastic revision of the system of allocating amateur transmitting permits. But if a change *is* made, what can replace it? Quite obviously, private persons wishing to transmit should be licensed as communication stations free to send whatever they wish provided they do not accept reward. This is the practice in the United States, where it has resulted in the growth of the strongest communications network in the world. There is one amateur transmitter for every 3,000 people there, while the "density" in the United Kingdom is only one per 15,000.

Of course, if through a relaxing of the present laws a great increase in amateur transmission occurred in this country, extension of the amateur frequency bands would probably be needed—but perhaps that is a few hurdles ahead yet!

Assuming that the obtaining of a transmitting licence were made easier than it is at present, the danger would exist that all sorts of unqualified people would want to "go on the air," unless adequate deterrents were provided. Therefore, instead of furnishing experimental reasons for wishing to transmit, it is suggested that applicants should be required to undergo not only the present Morse test, but a simple practical examination as well. These should be repeated every two or three years to ensure that the licensee's knowledge had not become rusty.

The Morse test at its present 12 words per minute is child's play, and at least 15 w.p.m. should be required of anyone who aspires to become an operator in the full sense of the word.

An examination of this character would deter any licensee from using telephony only for the whole of his radio career, and completely forgetting his Morse. This is a widespread abuse in amateur circles.

The question of amateur telephony is, in company with the misuse of licensed power, the most vexed question in the amateur world to-day. The problem could be solved by requiring lincensees to undergo an additional examination in telephony operation, and on passing it to pay a slight additional fee to account for the extra ether space they occupy compared with Morse stations. (Strictly speaking, they should pay ten times the fee paid by Morse operators, but we will skip that!)

In the United States portions of each amateur band are allocated for telephony operation (except the 7,000 kc/s band, where 'phone is barred). In Great Britain this segregation is not permitted, since licensees must be free to "experiment" in whatever part of the bands they desire.

The resultant chaos is well known to all short-wave listeners.

It is common knowledge that the majority of British amateur transmitters pay little heed to the clauses in their permits relating to the restriction of their power to ten watts. Moreover, the G.P.O. appears to close one eye to the abuses that exist, for flagrant cases go unchecked even following the routine visit of the G.P.O. inspectors.

Drastic tightening of regulations in this regard should attend any revision of amateur transmitting licences. A sliding scale of fees, varying according to the input used, is badly required—with frequent inspection to ensure that the law is being observed.

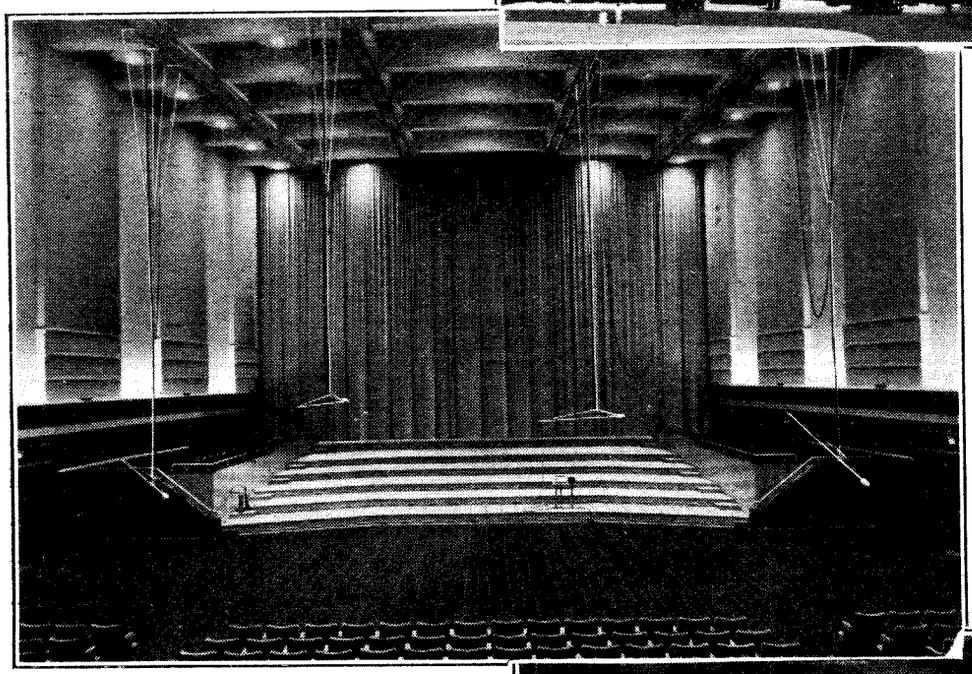
In one respect or another the amateur Augean stable needs a thorough cleansing. At present the amateur is controlled by the petty restrictions of an immediately post-war era, a clean sweep of which is long overdue.

# Belgium's Broadcasting House

## ACOUSTIC TREATMENT OF STUDIOS

AFTER some three years' work I.N.R. (Institut National Belge de Radiodiffusion) now has its first specially designed "Broadcasting House." Although not officially opened, the Brussels building is completely equipped, and it now remains only for the staff in the scattered apartments to move in.

Ample accommodation is provided for both the Flemish and French services, there being offices for each surrounding the two studio "towers." It is claimed that Belgium is now the possessor of the world's largest studio, which has seating accommodation for an audience of several hundred as well as the unique feature of a Royal Box. This studio, No. 4, has a volume of 15,000 cubic metres.



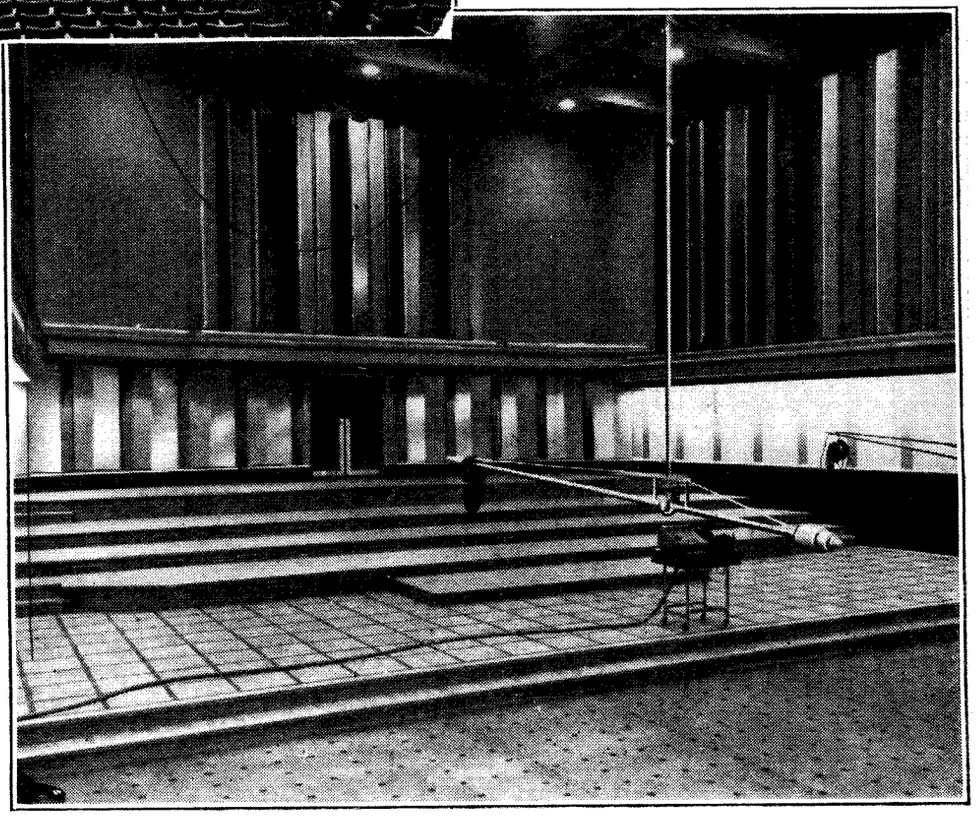
The walls of the world's largest studio (above) do not run parallel and the ceiling has a broken surface to overcome reflection effects. Note the trolley rails on the ceiling which carry the microphone arms. The rotatable pillars in Studio No. 1 can be seen in the illustration on the right.

There are nineteen studios in all, six of which are specially designed for the production of radio drama and are all visible from a central producer's box.

Quite a number of the studios can be adapted acoustically to meet the varied requirements of different programmes, but the most interesting features in this respect are incorporated in No. 1 studio, which has a volume of 3,000 cubic metres. Around the walls are arranged forty-eight hexagonal pillars, each having three different sound-reflecting and three different sound-absorbing surfaces.

These pillars are rotatable, being controlled from the producer's cabin and can be turned singly or in groups. Moving silently, they can be rotated during a production, thereby completely altering the acoustic characteristics of the studio. Each of the pillars, which are approximately 32in. in diameter and 15ft. high, is individually controlled, and can make a complete revolution in forty-eight seconds.

To ensure that the studios are completely sound-proof, walls, floors and ceilings are air- or cork-spaced from the next studio. The acoustic design of the studios and their equipment was undertaken by Monsieur R. Braillard, who is renowned for his work on the wavelength problem of European broadcasting stations and is the director of the wavelength-checking station of the International Broadcasting Union. M. Braillard was assisted by M. Mortiaux, chief engineer of the I.N.R.

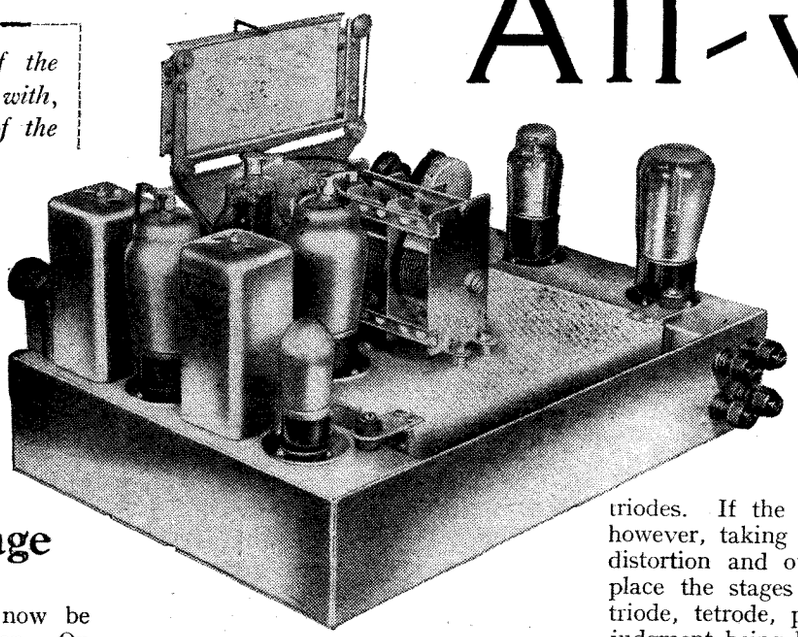


***How a Receiver is Designed.—XXVIII.***

# All-wave

## THE CIRCUIT DIAGRAM IN FULL

*THE theoretical aspects of the output stage are now dealt with, following upon the discussion of the early circuits which has been carried on in previous articles in this series. The receiver now takes shape as a connected whole and the complete circuit diagram is given.*

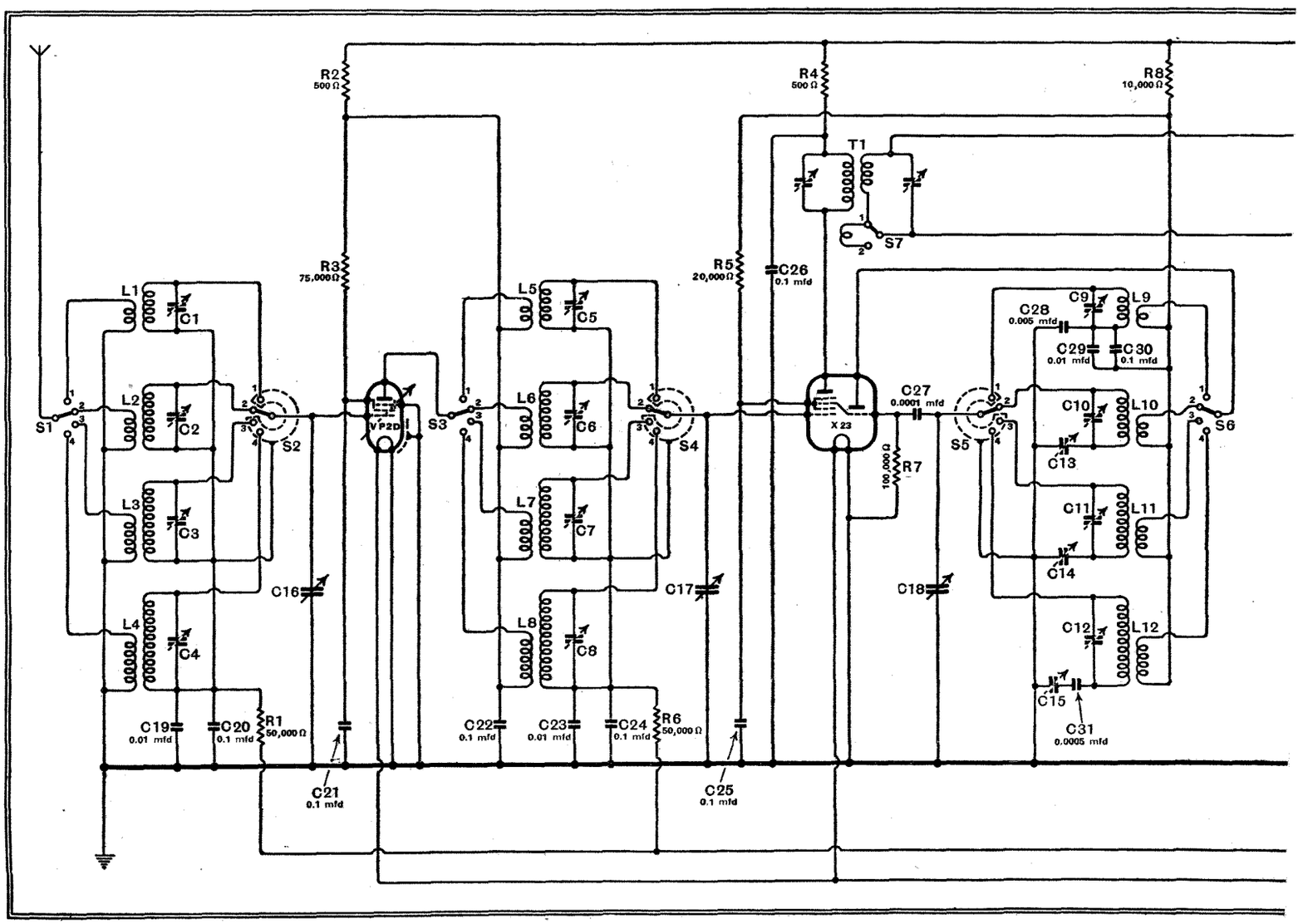


## Designing the Output Stage

THE output stage must now be given some consideration. On paper a Class B or QPP stage is the most economical, followed by the Class A tetrode or pentode, and then by the Class A triode. In practice, however, this order is often reversed and it is interesting to examine the reasons for this.

For a given average current consumption from the HT battery and for a constant percentage of harmonic distortion the quiescent types of output stage give more volume than tetrodes or pentodes and these in turn give greater output than triodes. If the experiment is repeated, however, taking no account of measured distortion and output, most people will place the stages in the order of merit, triode, tetrode, pentode, quiescent, their judgment being based solely on listening tests.

The reason for this apparent discrepancy is that measurements of total harmonic distortion do not indicate accurately what the ear hears. A total distortion of 5 per cent. is often considered permissible



# Battery Set

and this is probably true if it is made up chiefly of second harmonic with a little third and a negligible amount of higher harmonics. This is the condition encountered with triodes.

The distortion is audibly worse, however, if it consists of a predominance of third harmonic with an appreciable amount of higher harmonics, which is a condition found with pentodes. Quiescent stages sound still worse because they normally introduce higher proportions of high order harmonics. As little as 0.5 per cent. of the eleventh harmonic sounds much worse than 5 per cent. of the second.

### The Output Stage

Another way of regarding the matter is on the basis of modulation products instead of harmonics. It is found that such products are least with the triode and greatest with the quiescent stage.

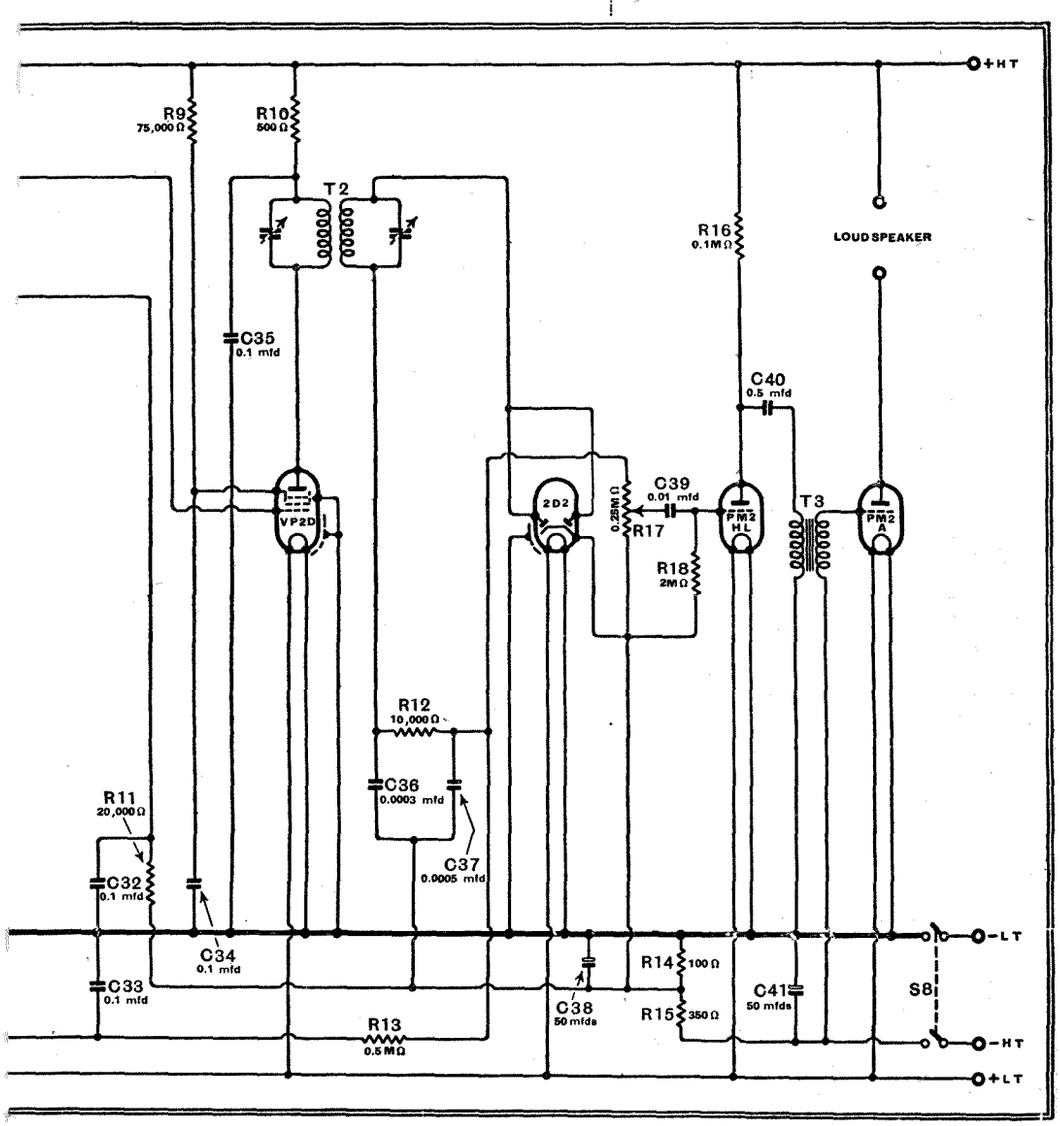
Still another factor comes into the picture. If we operate at full output with a certain degree of distortion and then reduce the output we expect the percentage distortion to fall more rapidly than the output. This is the case with triodes and to a slightly lesser degree with tetrodes and pentodes, but with a quiescent stage it is quite possible for the distortion to *increase*. This is especially bad because the ear seems particularly sensitive to distortion at low volume levels.

In spite of these points which tell against tetrode, pentode, and quiescent output stages, they most certainly have their uses. By very careful design the quiescent stage can be made to give an extremely good performance from the quality viewpoint. Careful matching of output valves is needed, however, with a first-class output transformer and accurate matching of the loud speaker. Tetrodes and pentodes are easier to deal with, but in the small battery types need such a high load impedance that the design of a suitable output transformer becomes difficult. They are also critical on load impedance and the use of negative feed-back is advisable.

The triode is not in the least critical; a 50 per cent. change in the load impedance will probably be inaudible, it does not need anything special in the way of output transformers or correction circuits, and it does not require negative feed-back. The fact that its operating conditions are not critical is no reason for departing from the correct conditions, but it does mean that small unavoidable departures from these conditions are relatively unimportant.

We decide, therefore, to use a triode output valve and in order to make the most of its output it is necessary to choose a sensitive loud speaker. If the two cannot be obtained together, frequency response must be secondary to sensitivity, naturally within reasonable limits This is because the ear is much less sensitive to a tailing off in response at low and high frequencies than it is to harmonic distortion. With an insensitive speaker and a limited output from the receiver there will be more harmonic distortion for the same sound volume than with a sensitive speaker because the output valve must deliver more output in the former case. Furthermore, a frequency response tailing off at the higher frequencies is not always a bad thing, for it reduces the effective harmonic distortion, especially of the high order harmonics. The improvement in quality from this cause may well be greater than the deterioration caused by the reduction of the upper register.

Fig. 3.—The circuit diagram of the receiver is shown here, and it will be seen that there are four waveranges. Of these, two are for short waves and the others for medium and long wavebands.




### The AF Circuits

It will be clear, therefore, that the design of a battery set is essentially a matter of compromise in which the ear is the final arbiter. Measurement naturally has its place, but one must rely far more on trial and error methods than in the case of a mains-operated set where plenty of power is available.

The complete circuit diagram is shown in Fig. 3 and it will be observed that transformer coupling is used before the output valve. At one time normal practice, this is now an unusual feature and it is adopted because it enables us to obtain something for nothing, at any rate in respect of battery power. The use of the transformer enables the gain to be raised to about four times that with resistance-capacity coupling and with no increase in the current taken from either LT or HT battery. There is a second advantage, which is that if the output valve is driven

**All-Wave Battery Set—**

into grid current, which may well happen on peaks with only a small output valve, the resulting distortion is less than with resistance coupling.

LIST OF PARTS

**Tuner chassis** — **B.T.S.**
**Main chassis** — **B.T.S.**
**1 Variable condenser,** 3-gang, 0.0005 mfd., **C16, C17, C18** — **Polar C1703**
**1 Dial,** ratios 10:1 and 50:1 — **Polar "Micro Horizontal Drive"**
**Condensers:**
1 0.0003 mfd., tubular, **C36** — **Dubilier 4601/S**
1 0.0005 mfd., tubular, **C37** — **Dubilier 4601/S**
1 0.01 mfd., tubular, **C39** — **Dubilier 4601/S**
11 0.1 mfd., tubular, **C20, C21, C22, C24, C25, C26, C30, C32, C33, C34, C35** — **Dubilier 4603/S**
1 0.5 mfd., tubular, **C40** — **Dubilier 4608/S**
1 0.0001 mfd., mica, **C27** — **Dubilier 690W**
1 0.0005 mfd., mica, **C31** — **Dubilier 690W**
1 0.005 mfd., mica, **C28** — **Dubilier 691W**
3 0.01 mfd., mica, **C19, C23, C29** — **Dubilier 691W**
2 50 mfds., 12 volts, electrolytic, **C38 C46** — **Dubilier 3016**
**6 Trimmers,** 30 mmfds., **C1, C2, C5, C6, C9, C10** — **Eddystone 1023**
**6 Trimmers,** 60 mmfds., **C3, C4, C7, C8, C11, C12** — **Bulgin SW122**
**1 Trimmer,** 0.003 mfd., **C13** — **Bulgin CP7**
**1 Double trimmer,** 150-550 mmfds., **C14, C15** — **Polar 55**
**1 IF transformer,** 465 kc/s, variable selectivity, **T1** — **Varley BP124**
**1 IF transformer,** 465 kc/s, **T2** — **Varley BP122**
**1 AF transformer,** ratio 1:4 — **Bulgin LF33**
**Resistances:**
1 100 ohms, ½ watt, **R14** — **Dubilier F½**
1 350 ohms, ½ watt, **R15** — **Dubilier F½**
3 500 ohms, ½ watt, **R2, R4, R10** — **Dubilier F½**
2 10,000 ohms, ½ watt, **R8, R12** — **Dubilier F½**
2 20,000 ohms, ½ watt, **R5, R11** — **Dubilier F½**
2 50,000 ohms, ½ watt, **R1, R6** — **Dubilier F½**
2 75,000 ohms, ½ watt, **R3, R9** — **Dubilier F½**
2 100,000 ohms, ½ watt, **R7, R16** — **Dubilier F½**
1 500,000 ohms, ½ watt, **R13** — **Dubilier F½**
1 2 megohms, ½ watt, **R18** — **Dubilier F½**
**1 Volume control,** 0.25 megohm, tapered, **R17** — **Reliance SG**
**2 Valve holders,** 4-pin (without terminals) — **Clix Chassis Mounting Standard Type V1**
**1 Valve holder,** 5-pin (without terminals) — **Clix Chassis Mounting Standard Type V1**
**3 Valve holders,** 7-pin (without terminals) — **Clix Chassis Mounting Standard Type V2**
**1 Switch assembly,** 4-way; all plates single-pole, comprising 3-plates without earthing contacts, 3-plates with earthing contacts, **S1, S2, S3, S4, S5, S6** — **B.T.S.**
**1 Switch,** SPDT, rotary, **S7** — **Bulgin S92**
**1 Switch,** DPST, rotary, **S8** — **Bulgin S115**
**12 Coils,** viz., 1 each PA1, PA2, PHF1, PHF2, PO1, PO2, PA4, PA197, PHF4, PHF198, PO4, PO199 — **Wearite**
**1 Battery cable,** 4-way, with spades and plugs — **Belling-Lee**
**1 Terminal block,** 4-way — **Bryce 5C2**
**4 Terminals,** ebonite shrouded, A, E, LS(2) — **Belling-Lee "B"**
**3 Plug top valve connectors** — **Belling-Lee 1175**
**2 Lengths screened sleeving** — **Goltone**
**Miscellaneous:**
8 lengths Systoflex, 3 ozs. No. 18 tinned copper wire, etc. Screws: 84 ¼in. 6BA R/hd., 12 ⅜in. 6BA R/hd., 2 ¼in. 4BA R/hd., 2 ⅜in. 4BA R/hd., 4 1in. 4BA R/hd., all with nuts; 18 ⅜in. 4BA R/hd., with 3 nuts and washers to each. — **Peto-Scott**
**Valves:**
1 X23 — **Osram**
1 2D2, 1 PM2HL, 1 PM2A — **Mullard**
2 VP2D — **Tungsram**

The output valve is a PM2A taking about 5.5 mA. anode current and deriving its grid bias from the voltage drop across R14 and R15. The total current of the receiver flows through these resistances. The AF stage is a PM2HL operated with −1.5 volts grid bias obtained from the voltage drop across R14; its anode current is 0.5 mA., which can hardly be considered an extravagant consumption.

Preceding this valve is the diode detector which also provides non-delayed AVC. Its circuits are entirely conventional and need little description. It is fed from the IF valve through the IF transformer T2 tuned to 465 kc/s.

The IF valve is a VP2D operated with 75 volts screen potential obtained from the HT line through the 75,000-ohm resistance R9. A resistance is used in preference to a potentiometer because it introduces no waste of current. The grid bias is fixed at −1.5 volts and is obtained from the same point as the AF valve. Anode and screen currents are respectively some 1.3 mA. and 0.6 mA.

The transformer which precedes this valve and which couples the frequency-changer to it is of the variable-selectivity type. The control is by means of a switch and enables two degrees of selectivity to be obtained.

Turning now to the tuner, this has already been dealt with in essentials and there is little to add at this juncture. The RF valve is a VP2D operated under the same conditions as the IF valve, save that AVC bias is applied to it. With no signal it consequently consumes the same current. The X23 frequency-changer takes about 4.5 mA and the total consumption of the receiver is thus some 14 mA.

Both RF and FC valves have AVC bias applied to them and their current consumption is reduced on tuning in a signal. The total current is thus reduced and hence the grid bias on the output valve. This results in an increase in the output valve anode current on a signal. The effect is small but inevitable in any battery receiver using automatic grid bias.

*Full constructional details, together with instruction for the adjustment and operation of this receiver, will be included in next week's issue.*

# Random Radiations

*By "DIALLIST"*

## Not So Easy

A POTTER'S BAR reader asks me whether I find reception conditions, particularly of stations on the short waves, better in my new home than they were in the old one, about half a mile away and some 200ft. lower above sea level. When you come to think of it, it's awfully difficult to say whether or not you genuinely are getting better results on the short waves, for conditions vary so enormously from time to time. Unless two people were working receiving sets of the same type simultaneously in the two houses and were either in telephonic communication or keeping careful logs for subsequent comparison, you wouldn't know whether or not apparently improved results were due to specially good conditions. Similarly, if in the first week or two you consistently hear certain stations that you either didn't hear at all or heard very seldom in the old place, it's tempting to jump to the conclusion that reception is better all round; but the wise course is, I feel, to gang warily and wait a bit.

## First Impressions

Frankly, my impressions after three weeks in the new locality are that I'm getting better short-wave reception, taking it by and large. But it mustn't be forgotten that the first part of October was abnormal owing to the presence of a gigantic sunspot which was travelling across the sun's disc. Short-wave reception was distinctly odd at times, some of the short-wave bands being very lively at hours when normally one would expect them to produce hardly a twitter. There have also been times when the 19-metre band, usually a safe bet for the early evening, has been a very long way below the mark. I think I'll have to wait until conditions are more settled before I venture a definite opinion.

## Welcome!

FROM the comments I've heard, the new D.G., Mr. F. W. Ogilvie, made a very good impression during his maiden talk to listeners the other night. It struck me as a very friendly talk by a man who was clearly out to do his best to give listeners what they want within reason. I think he will be a big success in his new post, though I don't expect—or wish for—any spectacular changes. We've built up the best broadcasting service in the world and it's mainly only in points of detail that changes seem to be required at the present time. There is, however, one suggestion that I'd like to reiterate, for I have always felt that it is of the utmost importance.

## Hotch-Potch Programmes

At the present time the programmes are too much of a hotch-potch. The attempt is made to put something for everyone into both National and Regional programmes. Hence if you tune in the National and leave your receiver tuned to it, you may jump from Mendelssohn to hot jazz; from that to a church service and then to variety, crooning or Viennese waltzes. And if you leave your set tuned to a Regional station an equally queer assortment of the grave, the gay, of melody and cacophony may come your way. An attempt to listen to one or other of the main programmes for a couple of hours on end often strikes me as like sitting down to a meal which begins with rice pudding and continues by way of eggs and bacon, caviare, ox-tail soup, chocolate éclairs to tripe and onions, with a dish of porridge to top it off. I've always felt that each set of programmes should be designed on quite different lines; the

# Programme Features of the Week

THURSDAY, OCTOBER 27th.

Nat., 7.45, Flotsam's and Jetsam's "Guyed Book." 8.30, Talk on "Italy and the Mediterranean." 9.25, Herman Darewski and his Band. 10.20, "Mainly about Manhattan"—talk from America by Alistair Cooke.

Reg., 7.30, The Band of H.M. Canadian Grenadier Guards relayed from Montreal. 8, I Knew a Man—Chekhov. Talk by Paul Shishkoff. 8.15 and 9.40, Sibelius Festival Concert—the London Philharmonic Orchestra.

*Abroad.*

Eiffel Tower, 8.30, "Malvina," operetta (Reynaldo Hahn).

Berlin Deutschlandsender, 10, Verdi opera music.

FRIDAY, OCTOBER 28th.

Nat., 6.25, The English Family Robinson. 7, "Hugh the Drover"—a romantic ballad opera. 9.25, "Advance in the Air." 9.45, Variety from the Royal Albert Hall, including Gracie Fields.

Nat., 7.30, Famous Music Halls: The Argyle Theatre, Birkenhead. 8.30, Louis Levy presents "You Shall Have Music." 9.15, Sussex by the Sea—a travelogue.

*Abroad.*

Vienna, 7.10, The Vienna Symphony Orchestra.

Sottens, 8.25, Act II "Samson and Delilah," opera (Saint-Saëns) from the Grand Theatre, Geneva.

SATURDAY, OCTOBER 29th.

Nat., 5, Billy Cotton and his Band. 7.30, In Town To-night. 8, Sing-Song, including Turner Layton and Clapham and Dwyer. 9.25, American Commentary.

Reg., 6, "Musical Seesaw" from America. 8.30, "The Shaft," a Cornish Legend. 9.40, "Night Shift"—the activities of the London Ambulance Service.

*Abroad.*

Stuttgart, 7.10, "Schön ist die Welt"—a play about Lehár, with the Composer's loveliest music.

Milan Group, 8, "Turandot," opera (Puccini).

SUNDAY, OCTOBER 30th.

Nat., 1, The Gerrard Singers. 3, Orchestral Hour with the New Metropolitan Symphony Orchestra at the People's Palace. 5.20, The Kutcher String Quartet. 9.5, The Cloister and the Hearth—Serial.

Reg., 4, Rhythm Classics. 6.30, Sunday Evening Concert, conducted by Sir Henry Wood, with Clifford Curzon, pianoforte. 9.35, "The Thin Red Line"—Chronicles of famous regiments, No. 1. The Grenadier Guards.

*Abroad.*

Cologne, 7.10, "Madame Butterfly," opera (Puccini).

Frankfurt, 7.10, "Carmen," opera (Bizet).

MONDAY, OCTOBER 31st.

Nat., 6.40, Puzzle Corner. 7, Monday at Seven. 8.50, Men Talking. 8.10, Reginald Foort. 9.25, World Affairs.

Reg., 7.30, The Week on Wall Street. 8.30, Night Journey. 9, The Pig and Whistle. 9.30, Jazz Biography of Benny Goodman, illustrated with recordings.

*Abroad.*

Leipzig, 7.10, "I Lombardi," opera (Verdi).

Brussels I, 8, Schubert pianoforte music, with verbal interpretations.

TUESDAY, NOVEMBER 1st.

Nat., 7.30, An Enquiry into Class—Wealth. 9.40, A Jack Hylton Production. 10.15, The St. Hilary Players in "The Eve of All Souls"—a Miracle Play.

Reg., 7.30, Tommy Matthews and his Concert Orchestra. 8, The Under Twenty Club. 8.30, "Hugh the Drover."

*Abroad.*

Vienna, 6, "Parsifal," opera (Wagner) from the State Opera.

WEDNESDAY, NOVEMBER 2nd.

Nat., 6.20, "Whitehall Tour"—Ministry of Health. 7.30, Photography in the Service of Science. 7.45, The World Goes By. 8.15 and 9.35, Queen's Hall Symphony Concert.

Reg., 6.35, Paul Temple and the Front Page Men, episode I—"Murder in the Afternoon." 8.15, Band Waggon. 9.15, Variety from Carlisle.

*Abroad.*

Paris PTT and Strasbourg, 8.30, Verdi's "Requiem."

Regional, say, being thoroughly low-brow all through and the National of a more elevating though not necessarily high-brow kind. After all, modern receivers being what they are, the number of people who can't receive alternative programmes must be minute nowadays. What, then, is the point of making both National and Regional contain one man's meat and the same man's poison ?

## Big Jump

THE licence figures for September were really astonishing. The total jumped to 8,758,050, an increase of 410,810 for the twelve months from October 1st, 1937. The increase for the month was 68,294, the biggest September jump for seven years. It couldn't have been due to panic buying of battery sets by those who already owned mains receivers and feared that current supplies might be cut off, for such folk would be in possession of receiving licences. Probably a good many people who hadn't receiving sets went in for them during those anxious days in order to be able to hear the frequent news bulletins. It is possible, also, that no small number of "pirates" feared that all would be discovered if a state of emergency arose and decided to take out licences whilst the going was still good.

## Polyglot News

MANY people with whom I've chatted are delighted that the B.B.C. is continuing to send out its calm, matter-of-fact news bulletins in French, German and Italian. They're being transmitted, as you know, from the London Regional; but this station is well received and well known in many Continental countries. From what I hear, the bulletins are welcomed abroad and it's not surprising that they should be in some countries. No names, no pack drill; so I won't particularise! But when I am in London I usually visit a little shop which sells the daily papers of many different countries and buy two or three of them to see what sort of news of the rest of the world is percolating to the citizens of certain lands. The little that some of them are told by their papers about important doings elsewhere is really amazing. It is not unusual to find that, though a whole page is devoted to news from abroad, it consists entirely of items so utterly trifling that our papers, if they mention them at all, don't give them more than a few lines.

## Another Side To It

There's another side, too, to these polyglot news bulletins from the London Regional. Many British folk listen to them because they find them so valuable a means of brushing up their knowledge of foreign languages. That they certainly are, if one cares to make use of them. If you've read your evening paper or if you heard the first home news bulletin, you can guess the subjects of many of the news items that will be broadcast at seven o'clock. Knowing the gist of them, you probably won't find it at all hard to follow them in whichever of the three languages you know best. And if that happens to come first it's a great help towards understanding what is said in the other two. I hope that we'll keep these foreign-language bulletins going for some little time and I am sure that listeners as a whole won't grudge the programme time that is to be devoted to them.

## Straws Show

IT'S rather interesting to notice what kind of television articles the American wireless papers are publishing. Some of them have crabbed television in this country so heartily and had so much to say about the amazing progress made in the Unitd States that one might expect them to be offering their readers articles very much of the up-to-date kind. There are those that do so, but others are publishing now the kind of television article that you read in *The Wireless World* two or three years ago. I haven't the faintest doubt that America's technical men who are working on television are right in the forefront; no one could deny, or would wish to deny, that several of the most important recent discoveries have come from American laboratories; but the average radio enthusiast in the U.S.A. must know very little about the subject if it is fair to judge by the standard of the articles offered by the more popular papers for his delectation and his instruction. After all, there isn't much inducement for him to study the subject, for it doesn't seem likely that there will be regular services, even in the big cities, for some time to come.

## Moths and the Aerial

YOU may remember that I mentioned last week that a reader wrote to me saying that he recalled a lecturer on zoology describing an instance of moths clustering round the aerial of a ship whilst transmission was in progress. The lecturer in question was Professor James Ritchie, Head of the Department of Zoology, Edinburgh University. I wrote to him to ask whether he could give any further information about the event and he has very kindly replied. He tells me that the original account of the assembling of the moths was in a letter published in "The Entomologist" during a discussion of the subject. He was unable to put his hand on his original note and so could not give the reference. Possibly some reader who is a "bug hunter" may be able to turn it up.

## A.C. SHORT-WAVE THREE

IT has recently transpired that resistance R15 in the AC Short-wave Three receiver, described in our issue of October 6th last, would be far more effective as an anti-parasitic stopper if it was joined in the screen grid lead to the valve rather than in the anode circuit. It must be connected direct to the valve pin.

As employed in the original case its usefulness is vitiated by the incorrect connection of C14, which should be joined to the loud speaker and not the valve side of R15.

### "Car Aerials"

In this article, published in last week's issue, the height of the aerial wire A-B from earth in Fig. 2, should have been indicated by the letter *h*.

# Intermittent Faults

## LOGICAL DEDUCTIONS FROM OBSERVED SYMPTOMS

By "TRIMMER"

*WHEN a cursory examination, made on the lines discussed in the first instalment of this article, fails to reveal the location of an intermittent fault in a broadcast receiver, some hard thinking is generally called for. Time will generally be saved by studying the symptoms carefully, and then attempting to deduce from their nature the probable position of the fault.*

**(Concluded from page 349 of last week's issue)**

CONTINUOUS faults in the AVC system of a receiver do not generally provide any unusual difficulty, but intermittent faults can produce results that may sometimes be puzzling unless the possibility of AVC trouble is realised and a check made.

With a receiver containing a visual tuning indicator there is, however, not much chance of being caught napping with an intermittent AVC fault because the tuning indicator will act as a tell-tale. In other cases, and if there seems any reason to suspect the AVC, it is a good plan to insert a milliammeter in the anode circuit of one of the controlled valves and to put the receiver on soak test, using a testing oscillator to provide a strong signal of constant amplitude and modulation. Any intermittent fault that has the effect of cutting out or of modifying the AVC biasing voltage will cause a change or fluctuation of the milliammeter reading, thus indicating that there is something wrong in the AVC system.

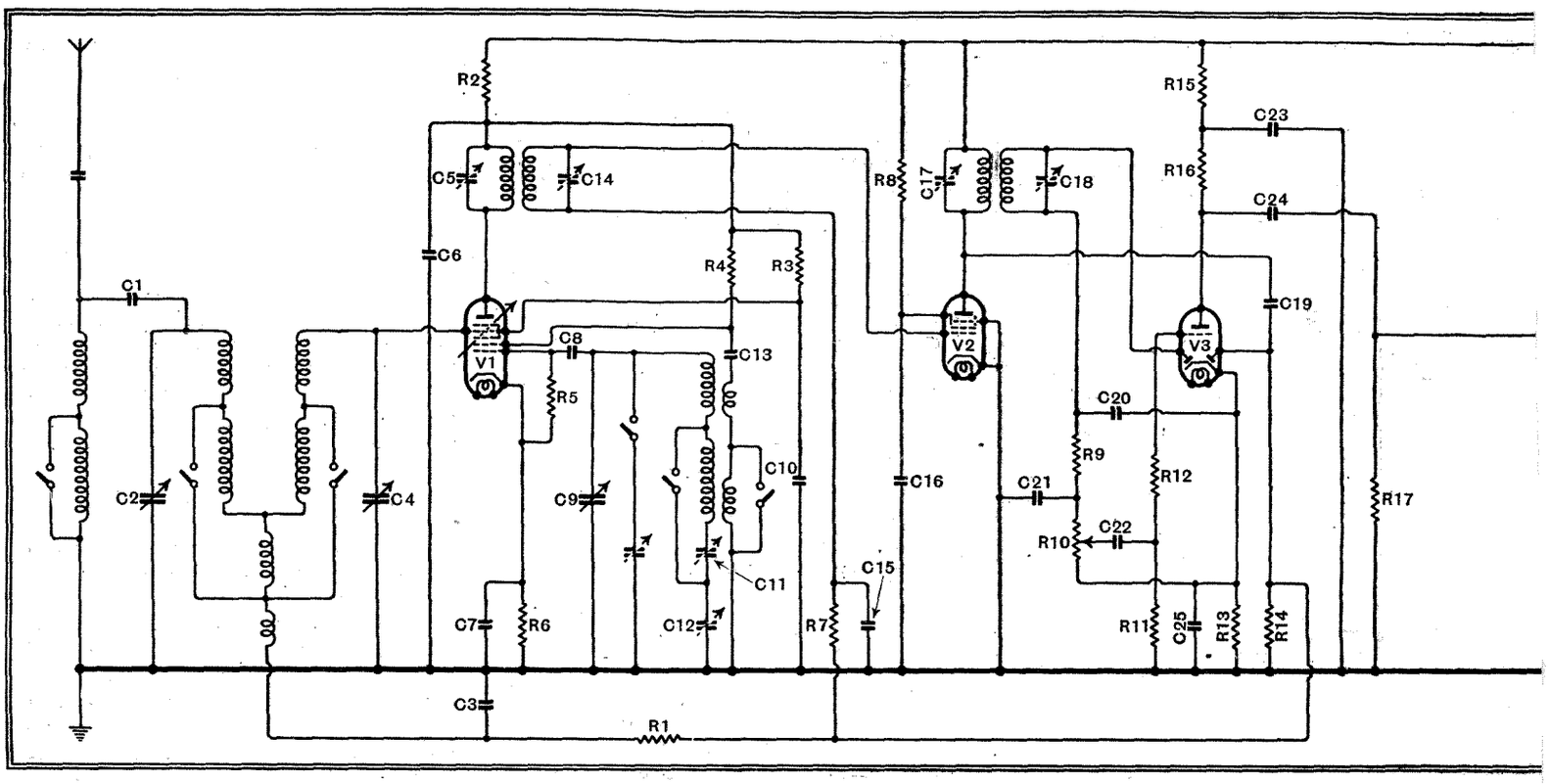
The effects produced by an intermittent fault depend so much upon the circuit position and function of the component concerned that any detailed consideration of particular cases renders necessary reference to a circuit diagram. For this purpose Fig. 3 is given, this being a diagram of a typical MW LW AC superhet.

### Intermittent Distortion

It is particularly important with this type of fault that the nature of the distortion should be very closely noted and also the characteristics of any subsidiary symptoms. Sometimes the latter will be important enough to lead directly to the discovery of the fault.

To take an example, suppose that intermittent distortion occurs with the receiver of Fig. 3. The distortion is very bad indeed, speech becoming hardly intelligible and music anything but music. It is further noticed that the volume drops when the distortion occurs. The distortion is so particularly bad that it becomes a matter of decided interest to find out what happens in the tetrode output stage when the fault occurs. What happens to the milliamps? This question is now particularly important and as the output stage is under such suspicion the milliammeter should be placed directly in the output anode circuit (otherwise it would be placed at the point marked X). The receiver is put on soak test with the milliammeter in circuit and it is found that a considerable rise in anode current occurs when the fault comes on. This is enough to indicate that trouble is associated with the output stage. What now are the fault possibilities? The valve may be faulty, of course, but there is one component shown which should now be regarded with decided suspicion; this is the grid coupling condenser C24. Intermittent low-resistance leakage, or short-circuiting, through this condenser would throw positive bias on to the grid of V4 and account for the symptoms described. The question of checking up on C24 now arises. It must not be forgotten that the fault is intermittent. Straight testing of the condenser may show it to be faulty,

Fig. 3.—Circuit diagram of a typical superheterodyne, used to illustrate the position of the majority of intermittent faults discussed in this instalment.



but a simple and useful check would be to disconnect it while the fault symptoms are actually on. The behaviour of the milliammeter is the point of importance now and if C24 is leaking the milliamps will drop as soon as it is disconnected.

Another fault which would give distortion with a rise of tetrode anode current would be excessive leakage through the bias condenser C26 although the effects would not be so severe as those of a short or low resistance leak through C24.

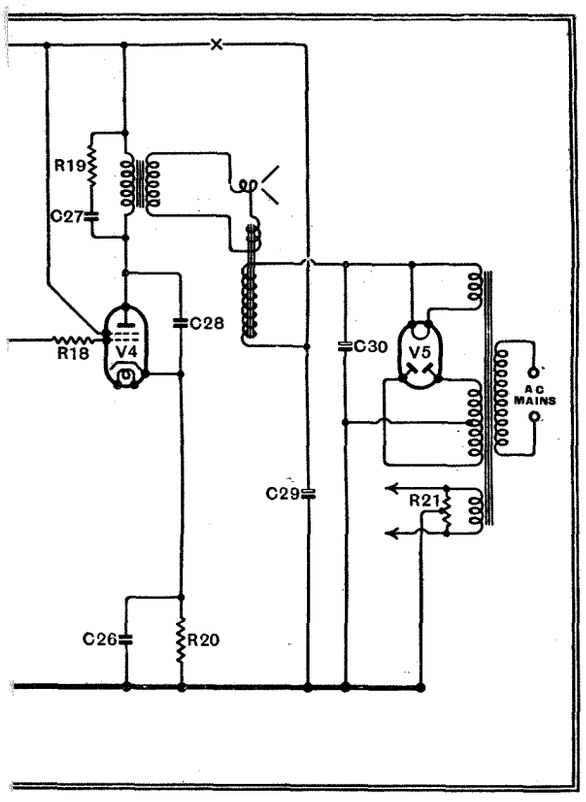
Cathode-to-heater leakage in V4 is another possibility ; a rise in hum level can be anticipated as one of the indications in this case.

### Defective AVC System

If the trouble is that of intermittent distortion which is evidently of the output valve overload kind and can be removed by cutting down on the volume control the question as to whether the AVC is cutting out is worth considering. A possible fault would be an intermittent open circuit in C19, the AVC feed condenser.

The importance of very close observance of symptoms cannot be over emphasised. Care in this matter may save a lot of time and trouble, particularly when the distortion is not very severe. Take the case of intermittent drop of capacity of C24. Probably the consequent drop of volume would be the more important factor to work on, but as regards distortion the attenuation of low notes is well worth noting as a valuable indication. Incidentally, attenuation of low notes would also be a sign of a drop in capacity of C26.

Where a sudden occurrence of high note attenuation is noticed the compensating condenser, C27, should come under suspicion. It may be intermittently leaking.




There are a number of intermittent faults, of the type that cause distortion, which can occur in the speaker. Mechanical faults such as intermittent fouling of the speech coil in the gap can usually be easily recognised by the nature of the distortion. The speaker is quite capable, however, of producing really tricky intermittent faults. One case was that of a dry joint in the speech coil circuit which introduced a fluctuating resistance, but only when the cone was moving beyond a certain amplitude. If there happens to be any doubt as to whether the speaker is behaving itself the simple idea of connecting up another test speaker may save a lot of unnecessary searching.

If signals intermittently cut out it becomes of importance, at the outset, to find out (1) whether the fault occurs on all wavebands, or only on one ; (2) whether the fault causes any change of milliamps (measured at point X, Fig. 3) ; (3) if there are any special peculiarities.

In connection with the milliamps question the warning previously given should not be forgotten and it may be advisable to make a voltage test first, if the cut-out occurs on all wavebands.

### Isolating the Fault

If the trouble occurs on one waveband only the IF and AF stages are removed from suspicion and attention must be concentrated on the RF and oscillator circuits. Anybody who has had much experience with intermittent troubles would at once begin to think of dry joint possibilities in the RF or oscillator coil assemblies. In this connection it must be noted that the presence of screening cans will very probably mean that these coils do not get any attention during the initial inspection and probing tests of the chassis.

It may become particularly important to ascertain whether the oscillator goes out of action when the cut-out occurs. The test would be to put the receiver on soak test with a milliammeter inserted to register the oscillator anode current (place it at the top of R4). In the case of the receiver illustrated the oscillator anode current will rise if the oscillations cease.

Intermittent cut-out on one waveband can, at times, prove to be quite a stiff proposition. One nasty case in the writer's experience was that of intermittent cut-out on long waves due to a drop of capacity of C8, the oscillator grid condenser. Conditions were such that the drop of capacity was just sufficient to stop the oscillations on long waves but not upon medium waves. The clue that led to the tracing of the fault was a slight intermittent rise of oscillator anode current on MW.

As regards the question of there being any special peculiarities, if such exist they may prove to be more important than the actual fact of cut-out. One superhet gave trouble by intermittently cutting out on long waves but only at the top end of the long waveband. The latter fact indicated that such a fault as a complete failure of a coil or condenser was not to be anticipated. The really important peculiarity was, however, that the failure of reception only occurred if the receiver was switched on, from cold, with the tuning set near the top end of LW. If the tuning was run down the scale and up again the reception would be restored. Actually, the trouble was more one of design than that of breakdown. It turned out that the amount of LW oscillator reaction coupling was reduced excessively and this made the valve characteristics a matter of extreme importance. A change of valve effected a cure. It was to be expected, however, that ageing of the replacement valve would probably bring recurrence of the trouble.

In the case where cut-out occurs on all wavebands and there are no special peculiarities a milliammeter at X may provide useful information. Such a simple fault as an intermittent open-circuit of R15 would soon be found. The drop of milliamps at X would suggest the possibility of a valve cutting off.

When there is cut-out on all wavebands and the milliammeter provides no conclusive information a lot of time can often be saved by locating the faulty stage with the aid of a testing oscillator. In view of the intermittent nature of the fault the tests will take time, but will probably save time in the long run. The output of the testing oscillator (at RF, IF or AF, as the case may be) should be applied to the modulator grid of V1, modulator anode of V1, grid of V2, and so on. At any one test point the test signal should be kept on either until cut-out occurs or until it seems reasonably certain that the faulty stage has been passed.

Where cut-out on all wavebands is concerned, and there is no indication that the fault causes a milliamp change, the speech coil circuit of the speaker should not be forgotten. A check on this would be to put the receiver on soak test with an output meter connected across the primary of the output transformer. If the output meter reading drops when the cut-out occurs the fault is not in the speech coil circuit.

### Secondary Symptoms

It is particularly important in this case to note whether the drop of volume is associated with any secondary symptoms. Is it accompanied by any distortion, and if so, of what kind ? Does the fault introduce a rise in hum level ? It is also of vital importance to know whether it occurs on all wavebands.

Where there are secondary symptoms it may pay to concentrate on these. Suppose that there is intermittent drop of volume on all wavebands, there is a noticeable increase of hum, and it is further observed that both HT volts and milliamps drop. The latter indication suggests HT supply trouble and coupled with the hum indication direct strong suspicion towards C30, the reservoir condenser. The trouble in one actual case was an intermittent open circuit in C30. (Large capacity electro-

**Intermittent Faults—**

lytics are, by the way, more prone to give continuous faults than intermittents.)

It may prove necessary, in order to make reasonable progress, to use a test oscillator for stage checking in the manner suggested above. Intermittent high-resistance leakage through C20, the diode load by-pass condenser, could well prove to be a sticky fault unless one knew definitely that the trouble was in the detector circuit.

Dry joint possibilities should never be forgotten.

There is no doubt that an intermittent crackle represents one of the worst types of fault symptoms if probing tests do not trace it; the fault can crop up practically anywhere in the receiver. A continuous crackle is usually not difficult to clear, but an intermittent one can sometimes be awkward.

A milliammeter at X may sometimes give some useful information. Suppose, for instance, that the anode decoupling condenser C23 has developed an intermittent high-resistance leak which, when it comes on, fluctuates sufficiently rapidly to set up a crackle. There will probably be a sufficient milliamp fluctuation to be noticeable and to indicate that leakage from the HT line is occurring.

### Tracing the Faulty Circuit

Stage cutting tests can be useful for locating the stage in which the crackle is being produced. With an AC mains or a battery receiver the simple method of lifting valves out will often lead to a quick localising of the faulty circuit.

When the faulty circuit has been located the tracing of the actual fault must be by a process of eliminating tests, the nature of which must necessarily depend upon the circuit arrangements. If the fault is evidently in the grid circuit of the output valve, then, to take this as an example, C24 could be checked up by disconnecting it. R18 could be shorted and C26 disconnected. If these items prove to be all clear there remains the grid leak, R17 and the bias resistance R20. It would not be good practice to short R20, but there should be no need to do so if R17 is shorted. If R20 does happen to be the offender the crackle should still be heard with the grid leak shorted, because, although the grid has been tied down to earth potential, the cathode has not.

Where hum is concerned it is necessary to draw a distinction between a case of hum that is independent of the signal and modulation hum (or "tunable" hum) that comes and goes as a signal is tuned in and out.

Where either kind of hum is concerned the fact of it being intermittent should first direct suspicion to valve cathode-to-heater insulation, this representing one of the most common causes of intermittent trouble.

Apart from the effect of a valve fault, ordinary hum (as distinct from modulation hum) is not very common as an intermittent fault. Where the trouble does crop up, and assuming that valves are cleared of suspicion, it becomes necessary to suspect the main smoothing system. Intermittent shorting of turns in the smoothing choke, or speaker field, sometimes occurs. This fault, however, will probably be easily and quickly detected more by its effect on the HT milliamps and volts than as a result of hum. The smoothing condensers, of course, can become associated with intermittent faults responsible for hum trouble, but, as previously mentioned, these condensers are more likely to produce continuous faults.

Intermittent modulation hum is sometimes rather a tricky matter. Fault possibilities depend very much upon the design features of the receiver. First and foremost, attention should always be directed to any arrangements incorporated in the receiver for the express purpose of preventing modulation hum, such as an earthed shield in the mains transformer (intermittent contact to earth?), any condensers across the mains transformer primary, or between primary and earth, any condensers between anodes and cathode of the rectifier, and so on.

It is worth noting that, dependent upon the design of the receiver, a valve may set up modulation hum if its operating voltages are wrong. Thus intermittent trouble affecting anode, screen or grid bias voltages may cause intermittent modulation hum. Again, the design of a receiver may be such that freedom from modulation hum is partly dependent upon one or more of the decoupling condensers. This raises the possibility of an intermittent drop of capacity being the cause of intermittent modulation hum. Fortunately, simple shunt testing with another condenser will show up this trouble. It is possible that an intermittent high resistance leak in a decoupling condenser will in certain cases be responsible for modulation hum. The fault would, however, probably be detected from other considerations than that of modulation hum.

Still referring to Fig. 3, there are obviously two items that could (but should not be) overlooked where intermittent hum is concerned. One is the hum-bucking winding of the speaker and the other is the centre-tapped resistance R21. An intermittent short of the former and a dry joint at one of the latter are possibilities.

## Television Programmes

**An hour's special film transmission, intended for demonstration purposes, will be given from 11 a.m. each week-day.**

THURSDAY, OCTOBER 27th.

**3,** Balloon Barrage. Viewers will see the inflation and ascent of a barrage balloon. **3.10,** "Poetic Justice," a telecrime by Arthur Phillips. **3.30,** Balloon Barrage (continued). **3.40,** 185th edition of Picture Page.

**9,** Ambrose and his Orchestra. **9.30,** British Movietonews. **9.40,** 186th edition of Picture Page. **10.10,** News.

FRIDAY, OCTOBER 28th.

**3,** A.R.P. Demonstration. **3.25,** Eve Becke in Songs. **3.35,** British Movietonews. **3.45,** Richard Hearne with Lily Palmer and George Nelson in "Bath h. & c."

**9,** Gaumont-British News. **9.10,** "Whistling in the Dark," a comedy thriller by Laurence Gross and Edward Childs Carpenter. **10.40,** News.

SATURDAY, OCTOBER 29th.

**3,** Cartoon Film. **3.5,** C. H. Middleton. **3.20,** Gaumont-British News. **3.30,** Ambrose and his Orchestra.

**8.30,** O.B. from Harringay Arena of part of the Ice Hockey Match between Harringay Racers and Streatham. **9.5,** "Pest Pilot," with Queenie Leonard and Eric Fawcett. **9.35,** Ice Hockey O.B. continued. **9.55,** British Movietonews. **10.5,** Music Makers. **10.15,** News.

SUNDAY, OCTOBER 30th.

**8.50,** News. **9.5,** Talk. **9.25-10.55,** "Cyrano de Bergerac," a play by Edmond Rostand, with Leslie Banks in the name part. (The first two-studio television production from Alexandra Palace.)

MONDAY, OCTOBER 31st.

**3-4.30,** "Whistling in the Dark" (as on Friday at 9.10 p.m.).

**9,** Starlight. **9.10,** Cartoon Film. **9.15,** Talk. **9.45,** British Movietonews. **9.55,** Pas Seul. **10.10,** News.

TUESDAY, NOVEMBER 1st.

**3,** "Order to View" No. 2. **3.35,** British Movietonews. **3.45,** Friends from the Zoo, presented by David Seth-Smith.

**9,** Friends from the Zoo. **9.15,** Gaumont-British News. **9.25,** "The Last Voyage of Captain Grant," a narrative of the Arctic. **10.10,** Cartoon Film. **10.15,** Music Makers—Dorothea Aspinall. **10.25,** News.

WEDNESDAY, NOVEMBER 2nd.

**3,** Little Show. **3.30,** Gaumont-British News. **3.40,** Cartoon Film. **3.45,** "Not According to Schedule." The scene is laid in a signalman's cabin somewhere on the Canadian Transcontinental Railway.

**9,** Jam Session. **9.20,** Film. **9.30,** "The Man with the Whisper," a short play. **9.40,** British Movietonews. **9.50,** Television Festival Dinner of the Royal Photographic Society. In the chair, H.R.H. Duke of Kent. Toast: "Our Guests." Reply by J. B. Priestley, followed by Gracie Fields and all-star cabaret from Alexandra Palace, for reproduction at the Dorchester Hotel. **10.30,** News.

## The Wireless Industry

TRIPLETT testing equipment comprising, among other instruments, a multi-range test set with the very high resistance of 25,000 ohms per volt, a signal generator and a valve voltmeter, is described in a pamphlet issued by The Universal Electrical Instruments Corporation, of 7, Rugby Street, London, W.C.1.

◈ ◈ ◈ ◈

A list of accessories for the service engineer has just been issued by Holiday and Hemmerdinger, Ltd., 74/78, Hardman Street, Manchester. Among new introductions is a set of trimming tools comprising special appliances for adjusting American and other receivers for which standard tools are unsuitable. The firm also holds the agency for the American Ghiradi "World Time Indicator," which shows standard time in any part of the world. The device costs 2s. 8d. post free.

◈ ◈ ◈ ◈

L. A. MacLachlan & Company, Strathyre, Scotland, have issued a list of components for use in the conversion or assembly of measuring instruments. These comprise shunts, multipliers, rectifier units, etc. Multi-scale dials, for fitting to standard milliammeters converted into multi-range instruments, are supplied.

◈ ◈ ◈ ◈

Messrs. Scophony, Ltd., of Thornwood Lodge, Campden Hill, London, W.8, have produced a booklet dealing with their television system. It explains briefly the chief features of Scophony television equipment, among which should be mentioned the supersonic light control. It is illustrated by photographs and drawings.

# NEWS OF THE WEEK

## GLASGOW'S NEW HEADQUARTERS

### B.B.C.'s Second Largest Studio

BROADCASTING House, Glasgow, which is to be opened on November 18th by the Rt. Hon. Walter Elliot, M.P., Minister of Health, formerly Secretary of State for Scotland, is the reconstructed building of Queen Margaret College. Number One of the ten studios is the second largest in the B.B.C., and larger than any in Broadcasting House, London. It has a floor space of 80ft. by 57ft., is 40ft. in height, and is beaten only by the largest of the studios at Maida Vale, London. The new General Purposes Studio to be incorporated in the extension to Broadcasting House, London, will be a close rival to it.

#### *Acoustical Treatment*

Number One, Glasgow, which is panelled to a height of over nine feet with Australian walnut, inlaid with bands of elm, is treated acoustically so that at one end the reverberation period is greater than at the other. There will be a five-tiered rostrum for the orchestra on the floor of the studio.

In the other nine studios the acoustical treatment consists of oak, plaster boards and panels treated with rock wool.

## AMERICAN TELEVISION

### "Up Above the World So High"

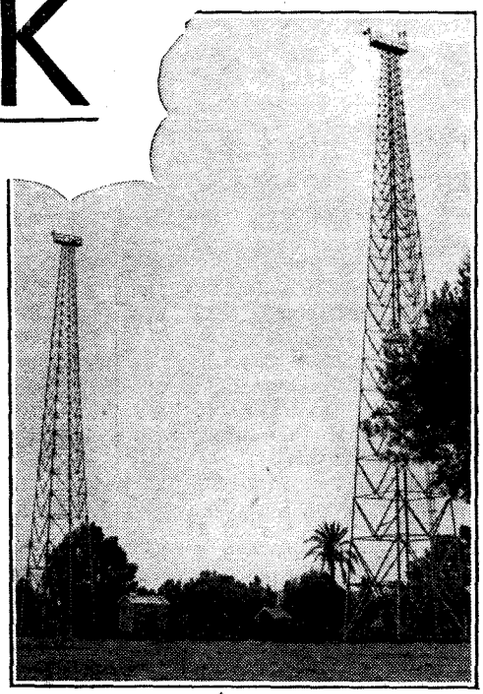
CONSTRUCTION of the Columbia Broadcasting System's high-definition television transmitter high up in the Chrysler Building, New York, presents fresh difficulties each day, as the workmen labour 900 feet above the level of 42nd Street.

Equipment weighing approximately 40 tons has to be moved from the manufacturing plant in Camden, N.J., through the busy city streets and piece by piece up the freight elevator to the 60th floor where it will be transferred by a special hoist 13 or 14 floors higher through a ten-foot square fire tower.

#### *Complications*

This work is particularly complicated by reason of the fact that it has to be done in the dead of night and over week-ends, in order not to disrupt the ordinary elevator service.

Now it has been discovered that the freight elevator, although it has been strengthened, is unable to lift the giant transformers for the transmitter. A bright suggestion that they should be drained of their oil is under anxious consideration, for the engineers would then be faced with the unwelcomed task of filtering the oil before it is replaced.



MASTS of the new 20-kW, 345.6-metre Tunis transmitter, which was inaugurated by M. Jules Julian, French Minister of Posts and Telegraphs, on October 14th. The transmitter is at Djedeida, which is about 20 miles from the station at Tunis. The station is equipped with receiving apparatus for the purpose of relaying the transmissions from the French Government short-wave station, Paris Mondial.

## BROADCASTING IN AUSTRALIA

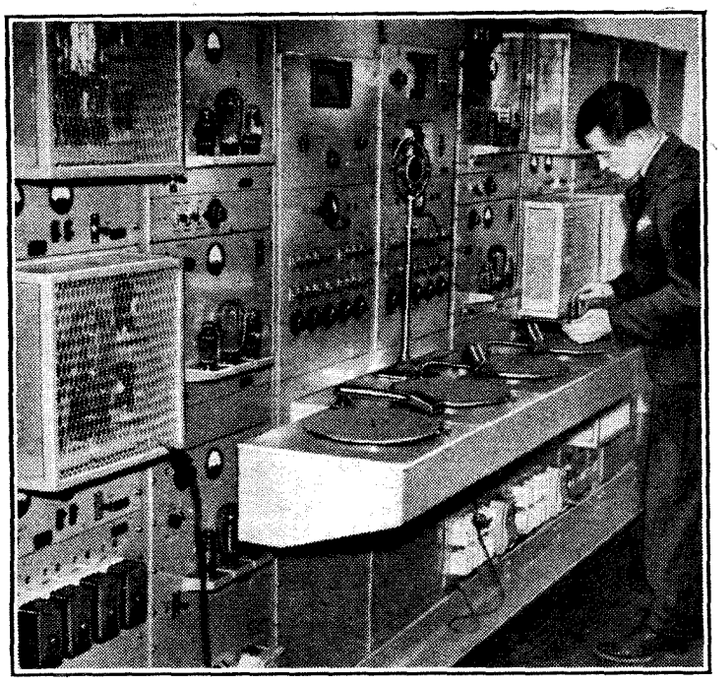
### Government and Commercial Stations

TWO out of every three of Australia's homes have wireless receivers, according to recent statistics. The number of wireless licences is well over a million, more than double the number of five years ago, and in the matter of radio popularity in the world Australia is now ranked fifth, despite the fact that a wireless receiving licence costs 1 guinea.

Wireless licences are issued by the Post Office, which retains 9s., while the remaining 12s. is received by the Australian Broadcasting Commission. The twenty-two Government-owned stations operated by the A.B.C. is just one-fifth of the total number of stations in the Commonwealth. The remaining four-fifths are privately owned commercial broadcasting stations.

Four main commercial networks cover the continent. These are Macquarie (19 stations), with its key station in Sydney; Commonwealth (21 stations), also with its key station in Sydney; Herald (12 stations), key station, Melbourne; and the A.W.A. (Amalgamated Wireless of Australasia), with 12 stations.

According to the *Advertisers' Weekly*, advertising revenue has grown tremendously, and it is estimated that the commercial station's revenue for the year 1938-39 will be £1,500,000.



FROM THE BROADCASTING ROOM in the Tower of Empire at the Empire Exhibition, Glasgow, have been radiated on an average sixty SOS messages a day, apart from the ordinary programme, during the six months' run of the exhibition, which closes on October 31st. Equipped by the General Electric Company, the system involves 15 microphone points and 130 loud speakers in various parts of the grounds.

## FINDING TELEVISION COMMENTATORS

THE B.B.C. staff at Alexandra Palace believe they have found the perfect commentator for televised ice hockey in Al Burton, an all-round radio man with experience in Hollywood and Paris, who emerged with flying colours from a novel test.

Faced with a recording microphone, Mr. Burton was told to describe an imaginary match. "Give me two minutes," said Mr. Burton. Jotting down the names of his imaginary players, he thought hard for a few moments and then signalled for the test to begin. Without a moment's pause he proceeded to describe a game with its thrills, penalties, mistakes and goal scorers—and the resulting record was so exciting that the judges almost forgot that the players were figments of Al Burton's lightning brain. His first commentary for the B.B.C. will accompany an ice hockey television transmission from Harringay on October 29th.

## LISTENERS IN AUSTRIA

ACCORDING to the first official figure from the German Ministry of Posts in Berlin, the number of Austrian licensed listeners stood at 643,389 on October 1st, 1938. The increase during the past six months, as yet unannounced, will probably be about 20,000.

The comparatively low "listener" density in Austria has brought down the listener-to-population proportion in Greater Germany to 14 per cent. from the previous 14.7 per cent. for Germany alone. It is probable that the present cost of a wireless licence in Austria (Rm.1.47 per month) will be

**News of the Week**

raised to Rm.2 by next April. This will then make the fee equivalent to that paid for a licence in Germany.

### BRITISH CONTRACT IN GREECE

PRIESTS of the Greek Orthodox Church blessed the new telegraphic and telephonic wireless receiving station at Loutsa, near Athens, during the laying of the foundation-stone by the Under-Secretary of State for Posts and Telegraphs. A transmitting station is to be built at Pallini, and the estimated cost of the two stations is £70,000.

Cable and Wireless, with whom the contract has been placed, will share the profits of the undertaking with the State for fifteen years, at the end of which period the State will assume entire ownership and control. The stations are expected to be operating within a year.

### INTER-EMPIRE BROADCASTING

NEW ZEALAND and Canada apparently hold divergent views on the importance of establishing short-wave stations for broadcasting to other parts of the Empire.

In Wellington, New Zealand, where work is going ahead on the construction of a broadcasting centre, the Government has decided not to permit the erection of a short-wave station at the present time. The Canadian Government, on the other hand, is being urged to erect a station which shall be a counterpart to the Empire broadcasting station at Daventry.

### B.B.C. PROGRAMMES FOR CAR DRIVERS

THE growing demand for car radio, as revealed by the Motor Show, has raised the question whether the B.B.C. should transmit certain programmes specially intended for car drivers. The broadcasts should give the driver something to occupy his mind without distracting his attention from the road, and it is stated in America, where such a scheme is in being, that the tendency is to prevent dangerous driving.

The ideal car programme might be difficult to create. Plays with tempestuous dialogue would have to be avoided, and love scenes of any emotional intensity would be banned from the start. Hot jazz, with its tendency to speed up traffic, would be excluded. Poetry readings would be soporific.

## *FROM ALL QUARTERS*

### Receiver Time Switch

MANY villages throughout India have been supplied with the "Indian Village" receiver. Housed in a plain metal box, it has no external controls. The set is permanently tuned to the local station, and a clockwork time switch turns it on for the "Village Hour" and off when that transmission is finished. The only attention required is the renewal of the battery and the resetting of the time-switch mechanism, which is necessary every three weeks.

### More Short Waves for N.B.C.

THE Federal Communications Commission has granted to the National Broadcasting Company two new short wavelengths. They are 31.02 metres (9,670 kc/s) and 13.76 metres (21,630 kc/s). With these additional frequencies, which were made available for international broadcasting at the Cairo Telecommunications Conference, the N.B.C. now has its complement of wavelengths necessary for maintaining an efficient day and night service to Latin American and European listeners throughout the year.

### Indian Directors in England

THE Directors of the A.I.R. stations at Lahore and Lucknow left Bombay last month for London, where they will take a course of training at the B.B.C. school. Among other guest students this quarter are: the Deputy Controller of Broadcasting at Hyderabad, and the Programme Director at Montreal.

### R.M.A. Banquet

MR. F. W. OGILVIE, Director-General of the British Broadcasting Corporation, will be the guest of honour at the Radio Manufacturer's Association's annual banquet which is to be held at Grosvenor House, London, on December 5th, when Lord Hirst will preside.

### Pirates of Bombay

ALL-INDIA RADIO now has a detector van which operates in Bombay for the tracking down of wireless pirates.

### "Aircraft Production"

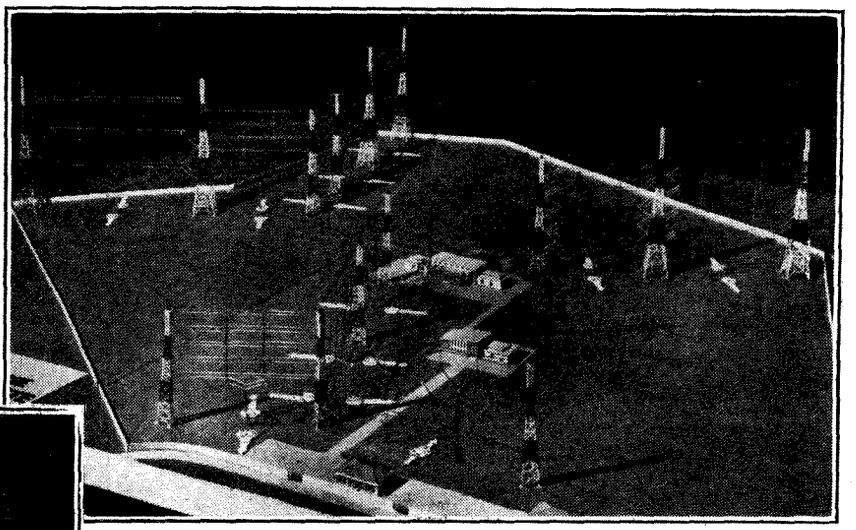
THE first issue, dated November, of *Aircraft Production*, the new one shilling monthly publication of Iliffe and Sons, devoted solely to the technical aspects of aero engine and aircraft design, appeared on the bookstalls yesterday, October 26th.

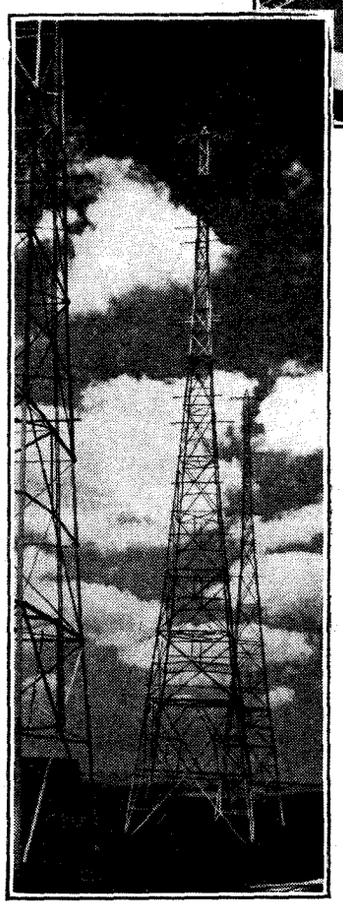
### School Broadcasting in India

ALL-INDIA RADIO is making a well-planned attack on the vast problem of broadcasting for schools. Transmissions will be given from Delhi in Hindustani, Calcutta in Bengali, and Bombay and Madras in English. Those from Madras have already begun, and about 20,000 children have been listening to the elementary school broadcasts.

### National Radio Engineers Association

THE first meeting of the winter session of the Association will be held on Wednesday, November 2nd, at 8.30 p.m., when a lecture on "The Commercial Applications of Piezo-electric Crystals" will be given by R. A. Rothermel, Ltd., Venue: The Durham Arms, Brentwood Road, Romford, Essex.





ITALY'S Imperial Short-wave Centre at Prato Smeraldo, near Rome, on which construction was begun in 1934, will, when it is completed, look like this model. Fourteen towers, varying in height from 180 to 300 feet, will support the directional and non-directional aerials. Below are some of the towers during the course of their erection.

## HIGH-POWER SHORT-WAVE CENTRE

### Italy's New Transmitters

THE Imperial Short-Wave Centre at Prato Smeraldo, near Rome, on which work was begun in 1934, will soon be put into service with four transmitters.

Two of these, the 25-kW I2RO3 and I2RO4, have been in use for some time, but the addition of two 100-kW transmitters, which are nearing completion, will bring Italy in the forefront of short-wave broadcasting, since it will then be the first country in Europe to use such a power.

The two 25-kW transmitters are to be reconstructed and their power raised to 50 kW in the near future. At present they employ the classic Heising system of modulation on the last stage, but when reconstructed they will employ Class B modulation.

The four transmitters, each of which will be able to work on two wavelengths, will be housed in a two-storey building. Another building will later be erected for the accommodation of two more 50-kW transmitters. Only one of these, however, will be installed at first. This will serve as a reserve transmitter and will be capable of working on six different pre-arranged wavelengths. It will be brought into use should any of the other transmitters break down, and for this reason it will be possible to link it with any of the aerials.

A new cable has been laid from the studios in Rome to the transmitting centre which makes it possible for four programmes to be relayed simultaneously.

It is expected that the two 100-kW transmitters will be put into service before the end of the year, and it is highly probable that test transmissions will commence before the end of this month.

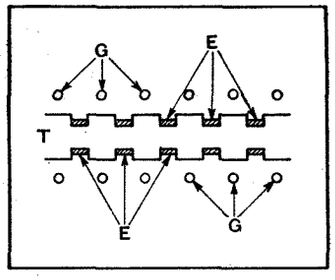
# Recent Inventions

***Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section***

### A CATHODE PROBLEM

IT is known that normally inactive electrodes, if placed opposite to an oxide coated cathode, tend to become active (so that they emit electrons) during the operation of the valve. This is due to the fact that particles of the "active" coating evaporate from the cathode and are deposited on adjacent bodies; the effect is not, as is sometimes supposed, due to surface diffusion or "creeping." It is in general undesirable, since it affects the characteristic curve of the valve, but it is particularly objectionable in the type of valve in which the electron stream should flow through the "gaps" between successive turns of a spiral control grid.

The Figure shows a method of




**Cathode construction, showing deposition of emitting material in grooves.**

coating an indirectly heated cathode which prevents any such undesirable activation of an adjacent control grid. The cathode consists of a tube T formed with grooves in which the emitting material E is deposited. The walls of the grooves restrict the spread of any evaporation that may occur, and prevent it from reaching the spirals G of the control grid.

*The M.O. Valve Co., Ltd.; M. Benjamin; and R. O. Jenkins. Application date, February 1st, 1937. No. 488873.*

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### SAFEGUARDING THE SCREEN

IF a cathode-ray tube is switched on, and the electron stream formed and brought to a focus on the screen before the scanning voltages come into play, the stationary spot is sufficiently intense to damage or even burn a hole through the fluorescent material.

According to the invention this risk is avoided by inserting a diode valve between the HT supply and the anode or accelerating electrode of the cathode-ray tube. The diode is so biased that it remains non-conductive for some seconds after the HT supply has been switched on, so that there is ample time for the saw-toothed oscillators to develop the usual scanning voltages before the electron stream can come into action. The spot is therefore moving rapidly over the screen as soon as it is formed, so that no danger of damage can arise.

*E. W. Bull. Application date, December 10th, 1936. No. 488655.*

### TELEVISION AMPLIFIERS

THE amplifying circuits used in a television receiver must be designed to respond to frequencies below that used for framing the picture—which are of the order of 25 changes a second. The circuits are therefore particularly susceptible to any low-frequency "ripple" that may be present in the mains supply voltage, with the result that disagreeable fluctuations of light will occur in the received picture.

To eliminate this source of disturbance, "graded" filter circuits are provided for the anodes of each of the amplifiers. In addition, the resistance-capacity elements used to couple the valves together are so dimensioned that any potential rise on the anode of one valve is automatically compensated by a corresponding drop of potential across the grid of the next valve. A method is given for calculating the values of resistance and capacity required to fulfil these conditions.

*Radio-Akt D.S. Loewe. Convention date (Germany), December 17th, 1935. No. 487242.*

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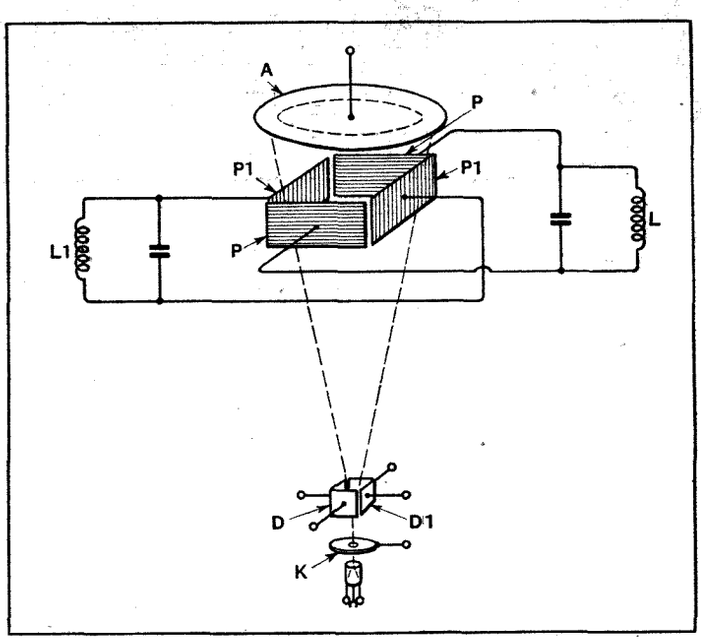
### SHORT-WAVE VALVES

THE Figure shows a valve of the so-called "deflection type," in which the electrons are controlled by a lateral movement, instead of by the more usual longitudinal grid control.




**Deflection valve with lateral control of the electron stream.**

The cathode K of the valve is associated with an arrangement of electrodes very similar to those forming the "gun" of a cathode-ray tube. As it passes through the two pairs of plates D, D1, the electron stream is subjected to deflecting voltages of equal frequency, but displaced in phase by 90 deg., so that it is given a circular motion around the imaginary cone, shown in dotted lines. In this condition it finally impinges on a collecting electrode A.

Before reaching the collector, however, the stream passes through what is called a "coupling-out" system of electrodes consisting of two pairs of plates P, P1, shunted by tuned circuits L, L1. Although it does not actually touch these plates, the passing stream induces charges on them, which, in turn, build up currents in the output circuits L, L1. The valve is stated to be particularly useful for generating, amplifying, or otherwise handling ultra-short waves.

*Telefunken Ges fur drahtlose Telegraphie m.b.h. [addition to 477668]. Convention date, (Germany), May 26th, 1936. No. 488747.*

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### SHORT-WAVE TUNING

A METHOD of tuning, particularly adapted for the short-wave bands, depend upon the use of a local-oscillator valve which generates a fundamental frequency of, say, 2 megacycles, and also harmonics of 4, 6, 8, etc., megacycles. The particular harmonic required is selected by switching an appropriate tuning condenser across a coil in the output circuit of the valve.

The range of tuning so provided is, in practice, found sufficient to cover all the available short-wave broadcasting stations, since these are at present arranged in widely separated frequency-groups.

The arrangement also lends itself to remote control of the set, the step-by-step adjustment of the local-oscillator frequency being effected by means of a dialling switch. For further precision, the known method of automatic fine-tuning is used to supplement the switch control.

*Murphy Radio, Ltd., and D. N. Truscott. Application date January 13th, 1937. No. 488717.*

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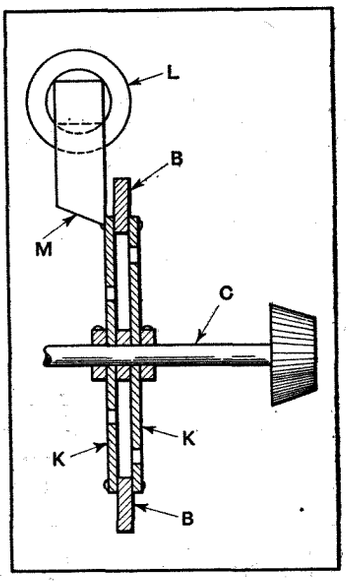
### AUTOMATIC "BRAKE" TUNING

AS the circuits of the receiver are brought into resonance with a worth-while station, a control current (derived, say, from the IF stages in the case of a superhet) has been used to apply a brake to the tuning shaft, so as to allow the operator to "feel" the correct adjustment. The braking action is of such strength that it exerts a definite check to the further rotation of the shaft, but by using a little extra pressure the operator can pass through the check on to another station if he so desires.




**Electro-mechanical automatic tuning system, in which a brake is applied to the condenser spindle at the position of resonance.**

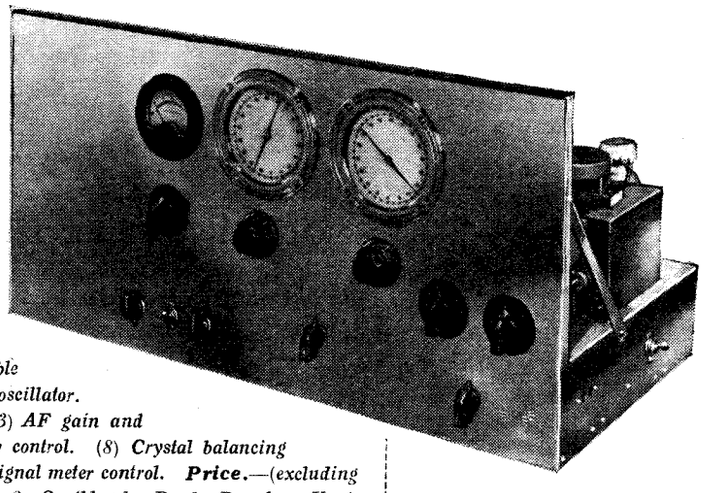
According to the invention, the braking current is only effective within a very narrow frequency band, and is applied to the energising coil L of an electromagnet M, which, as shown in the Figure, is fixed at a point quite close to a two-part disc K, carried by the tuning shaft C. A flat ring B of magnetic material is mounted between the two sides of the disc K, and is attracted towards the magnet M, when the latter is excited, so as to apply a perceptible "drag" on any further movement of the shaft C.

*N. V. Philips Gloeilampenfabrieken. Convention date (Germany) March 3rd, 1936. No. 487447.*

**The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.**

# Evrizone Communications Receiver

## HIGH SENSITIVITY MAINTAINED DOWN TO 5 METRES



**FEATURES.** ***Waveranges.***—*(1) 60 - 36 Mc/s. (2) 37 - 15.5 Mc/s. (3) 15.5 - 7.5 Mc/s. (4) 6.1 - 3.9 Mc/s. (5) 4.05 - 1.7 Mc/s.* ***Circuit.***—*Var. mu pentode RF ampl.—pentode mixer—pentode osc.—two var. mu pentode IF ampl. with crystal input filter—double diode push pull 2nd det.—triode 1st AF ampl.—pentode output valve. Var. mu pentode AVC ampl.—double diode AVC rect.—pentode signal meter amplifier—pentode beat-frequency oscillator. Full-wave valve rectifier.* ***Controls.***—*(1) Main tuning. (2) Band Spread. (3) AF gain and on-off switch. (4) RF gain. (5) Waverange. (6) AVC delay. (7) Selectivity control. (8) Crystal balancing control. (9) Crystal on-off switch. (10) Beat oscillator on-off switch. (11) Signal meter control.* ***Price.***—*(excluding loud speaker) £45.* ***Makers.***—*Evrizone Radio and Television Co., Ltd., 2, Southlands Road, Bromley, Kent.*

THE nucleus of this receiver is the Evrizone Super Tuner, a component which is available as a separate unit and is designed for use with an RF stage, separate oscillator and mixer valves.

The intermediate frequency is 465 kc/s, and the tuner covers a range of 5 to 176 metres in five overlapping bands. Selection of the appropriate band is made by means of a rotary-type switch of low capacity (1.9 micro-mfd. between contacts). The layout and design throughout have been skilfully handled to maintain circuit efficiency while keeping the physical dimensions small.

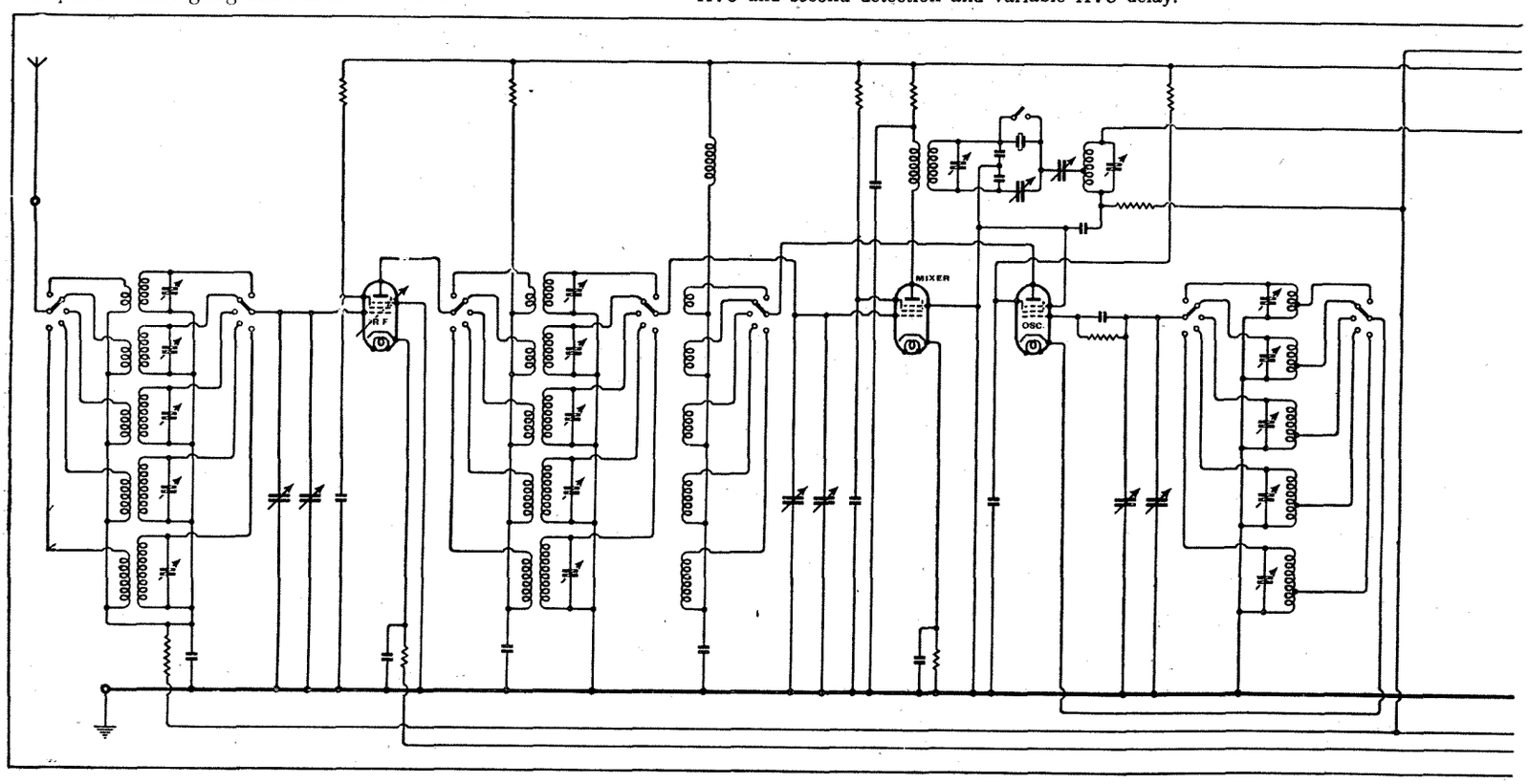
Separate three-gang condensers are used for main and band-spread tuning, and each condenser is fitted with a two-speed slow-motion drive. Only seven external connections are required between the tuner unit and the remainder of the circuit.

The circuit adopted by the makers employs eight valves in the direct line of amplification from aerial to output, and four auxiliaries for amplified AVC, signal strength indication, and beat frequency generation.

The RF amplifier is quite straightforward, but the frequency-changer connections are unconventional. Pentode valves are used for mixing and the generation of local oscillations, and the latter are injected into the signal frequency circuit via electron coupling in the oscillator valve itself and a series of coupling coils, one for each waverange. The advantage claimed for this arrangement is that it gives improved frequency stability. Our experience with the set confirms this view; no drift could be detected even at the highest frequencies.

There are two IF stages preceded by a crystal gate with the usual band-width and phasing controls. The conditions for

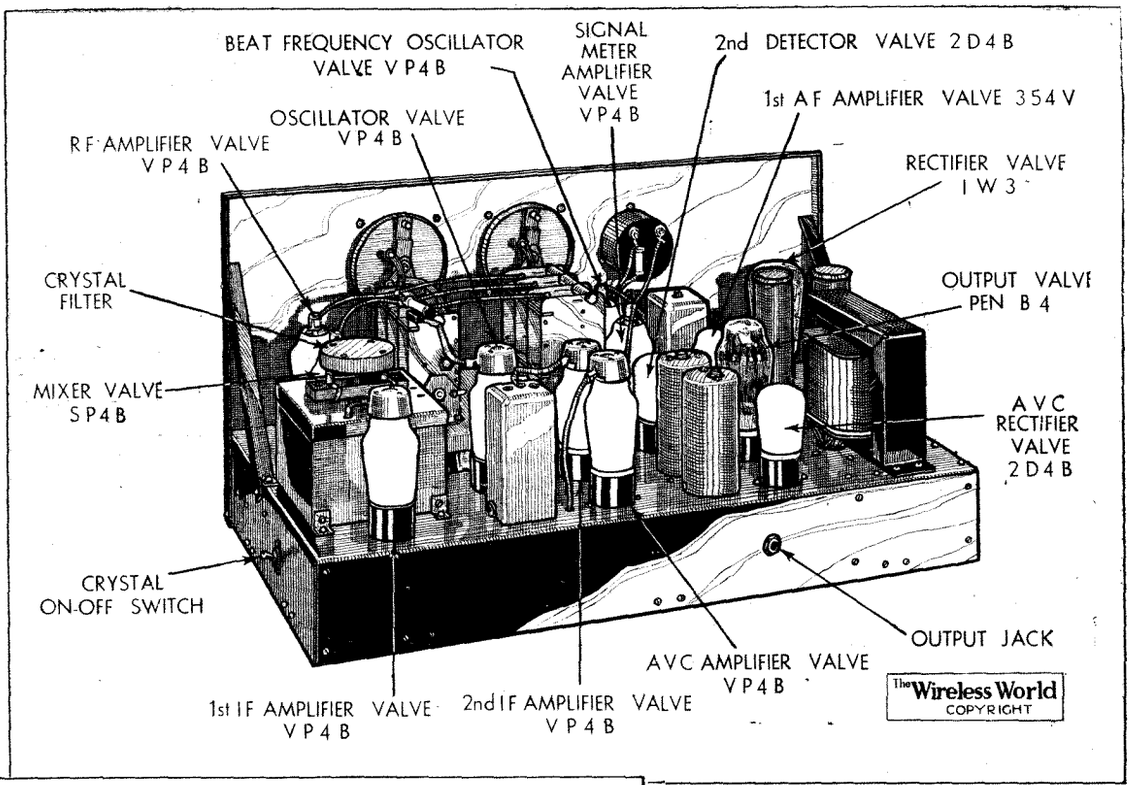
**Complete circuit diagram. Interesting features include combined electron and inductive coupling for local oscillator injection, single-signal crystal filter, push-pull diode rectifiers for AVC and second detection and variable AVC delay.**

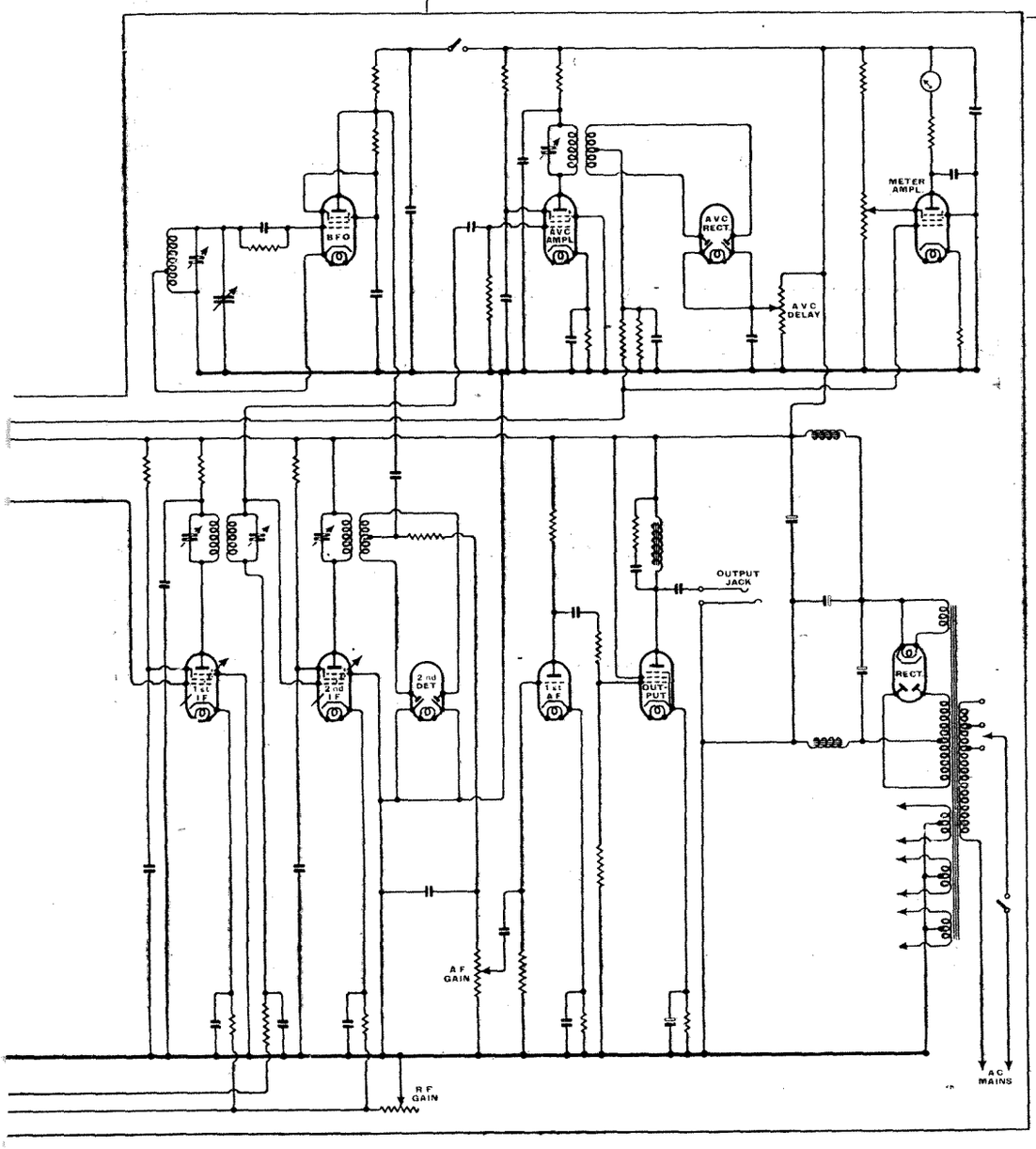


**Evrizone Communications Receiver—**

single-signal operation are easily found, and the set cuts off cleanly on one side of the zero beat without undue "ringing" in the crystal. A low-loss "Keremot" type mounting for the crystal is accessibly placed, and a switch at the side of the chassis short-circuits the crystal when not required.

A separate IF amplifier valve feeding a double-diode rectifier in push-pull supplies the AVC bias to the RF amplifier and IF stages. The RF gain control consists of a variable resistance controlling the initial bias of the RF and IF valves. AVC delay is variable, the bias being derived from a potentiometer across the main HT supply. It is not often that this control produces any effect on the signal, but it is a useful refinement in


BEAT FREQUENCY OSCILLATOR VALVE V P4 B
SIGNAL METER AMPLIFIER VALVE V P4 B
2nd DETECTOR VALVE 2 D4 B
1st A F AMPLIFIER VALVE 354 V
OSCILLATOR VALVE V P4 B
R F AMPLIFIER VALVE V P4 B
RECTIFIER VALVE I W 3
CRYSTAL FILTER
OUTPUT VALVE PEN B 4
MIXER VALVE S P4 B
A V C RECTIFIER VALVE 2 D4 B
CRYSTAL ON-OFF SWITCH
OUTPUT JACK
AVC AMPLIFIER VALVE V P4 B
1st I F AMPLIFIER VALVE V P4 B
2nd I F AMPLIFIER VALVE V P4 B
The Wireless World COPYRIGHT




**The power supply unit is incorporated in the main chassis. Components associated with the crystal filter are housed in a separate screening box on the left.**

reserve for exceptional cases. A setting midway between zero and maximum gave best results.

The signal meter (uncalibrated) is connected in the anode circuit of a pentode valve, taking its control bias from the AVC line. The zero is adjusted by a screen potentiometer, and deflections are in a downward direction, so that the meter cannot be damaged by a strong signal.

Push-pull diodes are used for signal rectification, and as no delay bias is applied, there is little chance of distortion in this stage. A separate triode provides a first stage of AF amplification before the pentode output valve. A fixed degree of tone compensation is provided by a resistance-capacity circuit in parallel with the anode choke. The output is filter-fed and is taken through a telephone jack, so that a matching transformer is necessary if a loud speaker is used. For the purpose of calculation, the load should be taken as 3,500 ohms.

It seems a little incongruous to find a telephone jack at the end of a chain of eight very efficient stages, and results justify the opinion that a loud speaker can be used for anything but record-breaking long-distance tests. Volume and quality judged on a high-grade permanent magnet speaker were excellent, and the extra sensitivity of phones was not called for when listening to American amateurs on the 10-metre band.

In spite of a notoriously troublesome local background in Central London, very steady phone signals at full loud speaker strength were picked up during the afternoon from amateurs working in the

**Evrizone Communications Receiver—**

Dominican Republic and Ohio, U.S.A. Sensitivity on the 5-metre band was also exceptionally good. Below the London television transmitters, where most receivers are comparatively dead, the Evrizone is full of life. Several unidentified experimental transmissions were picked up between 5 and 6 metres, and, judging by the amplification afforded to a well-known source of diathermy interference in the neighbourhood, we are confident in recommending this receiver for serious long-distance working on the 5- and 10-metre bands.

The signal-to-noise ratio throughout the range of the set is excellent, and, except under abnormal conditions of local interference, headphones could be used without aural fatigue from background noise.

Inevitably, there is some second-channel break-through on the two lower waveranges, but on the remaining three image rejection is satisfactory. Oscillator harmonics result in faint replicas of the television transmissions at one or two points, but these are soon recognised and are readily overlooked in face of such an excellent performance from the point of view of sensitivity. The possession of this receiver will put the owner in touch not only with every section of amateur transmitting activity, but will also bring in short-wave broadcasting with a far greater reserve of volume than is possible even in the best "all-wave" sets.

# On the Short Waves

DURING August, my friend G2MV, of Old Coulsdon, received a number of QSL cards from the U.S.A. relating to his 56 Mc/s transmissions. Actually all these cards related to one particular time and date, namely, 2015 G.M.T. on July 10th, 1938, and so we must assume that on this date a condition particularly favourable to transatlantic ultra-short-wave propagation existed in the late evening.

The reports came from several American zones or "districts"; four from W1, one from W9 and one from W6. But at the moment of writing G2MV is not entirely convinced that his 5-metre signals have indeed been received in America and he is now planning to clinch the matter by an attempt at two-way 'phone communication this winter.

It is often assumed that 56 Mc/s signals are propagated over very long distances by "classical" refraction via the F2 layer; if this is true, then a successful contact can only be established when the measured critical frequency of the F2 layer (at vertical incidence) is at least as high as one-third of 56 Mc/s—that is, about 18-19 Mc/s. Measured values as high as this are extremely rare, although during winter afternoons figures of 14-15 Mc/s for the critical frequency of the F2 layer are often obtained. If, however, a layer lower in height than the F2 is involved then a multiplying factor greater than 3 becomes possible; in fact, with a very low layer the maximum usable frequency for long-distance communication may be as great as five times the measured critical frequency at vertical incidence.

In order to take advantage of this latter condition, however, the transmitting aerial employed must be designed to shoot as much energy as possible almost tangentially along the surface of the earth, whereas, if transmission is taking place via the higher F2 layer, a projection angle of between 8° and 12° to the horizontal will be best—i.e., an optimum angle of 10°.

This latter angle is achieved by a horizontal stacked array of four elements spaced half a wavelength apart vertically, the bottom element being also one half-wave above the ground.

Top element of such an array would be two wavelengths high, i.e., 33ft.

For tangential radiation the largest possible number of stacks should be used, eight stacks probably being the greatest number necessary in practice. Instead of the 4-stack array described above, a rhombic aerial having four sides, each twelve wavelengths long and erected at a height of one and a half wavelengths above the ground might be employed.

Finally, if 5-metre transatlantic reception is via the F2 layer then peak conditions will probably be experienced in November and February, if not, then probably any time of the year is as good as another.

While reception of U.S. signals on 56 Mc/s is still a rare occurrence, conditions on 28 Mc/s have been very good recently, although one point calls for comment. It is that, quite apart from considerations of power and aerial design, 28 Mc/s signals at the moment seem to travel much more readily from west to east than vice versa. For example, on Sundays, October 9th and 16th, the 10-metre band was alive with U.S. 'phone signals, but most of the W stations were experiencing difficulty in working European stations.

The rather more southerly latitude of the U.S.A. may account for this, by providing rather higher ionisation there, and consequently a better take-off. Paradoxically enough, judging by the scanty data available, conditions on 56 Mc/s seem to be the reverse of this.

It will probably interest readers of this column owning all-wave sets which do not cover the 10-metre band to know that I am using an adaptor unit comprising an Acorn RF valve feeding into the grid top cap of the X65 triode-hexode mixer of a domestic all-wave broadcast set which is tuned to the 21-metre band. Thus 10-metre reception is being obtained by employing the second harmonic of the oscillator with no alteration to the receiver beyond the addition of a pretuned RF stage. On 10 metres a modern steep-slope RF tetrode is as efficient as the American Acorn I am using, but the British Acorn has a much higher mutual conductance. Results from the RF attachment are excellent, and I hope to published a sketch of the unit later.

To conclude, among the most interesting notifications in the Berne List are the following: W2XDG 40.6 Mc/s (7.389 m.) 5 kW, a new N.B.C. experimental transmitter in New York, and W2XS on the extremely high frequency of 401.0 Mc/s, an R.C.A. experimental transmitter at Rocky Point. The power in this last case is given as 10 kW! The frequency was first used in 1930.

Recent appearances in the broadcast bands are W3XAL on 9.67 Mc/s (W3XAL on its old frequencies of 17.78 and 6.10 Mc/s has now been replaced by W3XL) and Rome I2RO on 15.19 Mc/s, a strong but badly distorted signal. A new Siamese world broadcasting service was also inaugurated on October 20th with two transmitters operating on 19.02 and 9.50 Mc/s.

ETHACOMBER.

# News from the Clubs

### *Southend and District Radio and Scientific Society*

**Headquarters:** The Priory School of Dancing, 152a, High Street, Southend.
**Hon. Sec.:** Mr. J. M. S. Watson, 23, Eastwood Boulevard, Westcliff-on-Sea.

The Society recently held an all-night DX contest. There were approximately 50 participants, including visitors from the Ilford, Brentwood, Romford and Welwyn societies. The affair commenced at midnight and concluded with breakfast at 7.30 a.m.

### *Radio, Physical and Television Society*

**Headquarters:** 72a, North End Road, London, W.14.
**Meetings:** Fridays at 8.15 p.m.
**Hon. Sec.:** Mr. C. W. Edmans, 72a, North End Road, London, W.14.

The Society wishes to call the attention of intending members to the fact that it caters for other activities, apart from radio. During the last session the society held 31 meetings, of which 27 were lectures. In the summer a 2.5-metre field day was held and a party of members visited Croydon Aerodrome transmitting station. The non-radio lectures dealt with electric furnaces, chemistry, the optics of photography and the organisation of the rubber plantation industry. The annual subscription of 7s. 6d. entitles a member to many privileges, including morse instruction, a calibration service, technical advice and technical translations.

### *Sussex Short Wave and Television Club*

**Joint Hon. Secs.:** Mr. C. J. Rockall, "Aubretia," Seafield Road, Rustington; Mr. E. C. Cosh, "Auslyn," Mill Road, Angmering.

On September 27th Mr. E. J. Williams lectured on "The Effect of Sunspots and Magnetic Storms on Radio Conditions." On October 12th the Club had its annual outing, when a party of thirty made a tour of the works of Murphy Radio, Ltd., and received lectures on "Television" and "Ultra-short-wave Design." This evening (October 27th) a lecture-demonstration is being given at the Pavilion, Bognor Regis, by a representative of Voigt Patents, who will deal with "High quality Reproduction."

### *Short Wave Radio and Television Society of Thornton Heath*

**Headquarters:** St. Paul's Hall, Norfolk Road, Thornton Heath.
**Meetings:** Tuesdays at 8.15 p.m.
**Hon. Sec.:** Mr. R. E. Dabbs, 4, Nutfield Road, Thornton Heath.

On October 11th Mr. D. P. L. May demonstrated his Hallicrafter Sky Rider. The annual junk sale was held on Tuesday, October 18th. A general debate is being arranged on the question of "straight" or superhet SW receivers, and on November 8th G2RD and G2DP are giving a joint talk on 5-metre receiver design.

### *Croydon Radio Society*

**Headquarters:** St. Peter's Hall, Ledbury Road, South Croydon.
**Meetings:** Tuesdays at 8 p.m.
**Hon. Pub. Sec.:** Mr. E. L. Cumbers, 14, Campden Road, South Croydon.

On October 11th Dr. F. C. Stephan, head of the Research Department of T.C.C., Ltd., lectured on "The Latest Developments in Condenser Design and Construction."

The following visit has been arranged:

**November 1st.**—A visit to the Alhambra, Wellesley Road, West Croydon, at the invitation of the Surrey Radio Contact Club, when an address will be given by Mr. J. Clarricoats, secretary of the R.S.G.B.